AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

Dairy Engineering Number

VOL.11 JANUARY 1930 NO.1

Engin-Mahr

AGRICULTURAL ENGINEERING

Published monthly by the American Society of Agricultural Engineers
Publication Office, Bridgman, Michigan. Editorial and Advertising Departments at the Headquarters of the Society, Saint Joseph, Michigan

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to members of the Society, $2.00 a year. Postage to countries to which second-class rates do not apply, $1.00 additional. Entered as second-class matter, October 8, 1925, at the post office at Bridgman, Mich., under the Act of August 24, 1912. Additional entry at St. Joseph, Mich. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title AGRICULTURAL ENGINEERING is registered in the U. S. Patent Office.

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How Shall Future Dairy Engineers Be Trained?[1]

By J. H. Godfrey[2]

MY PURPOSE is to direct attention to this question with the hope that we can crystallize opinion and perhaps induce educational institutions to provide the kind of training dairy engineers should have to cope with the problems before us today and in the future.

Our industry is comparatively young. Within a generation dairy product manufacturing has been transformed from a farm into a factory enterprise. While our raw material comes from the farms, our problems are no more those of agriculture than are the miller's problems, for example. Our industry is young in years but very large in volume. No less an authority than the Hon. Arthur M. Hyde, Secretary of Agriculture in President Hoover's Cabinet, has recently quoted figures showing that the output of milk processing manufacturers exceeds in value the output of either the automobile or steel industries, which are generally regarded as our leading industries.

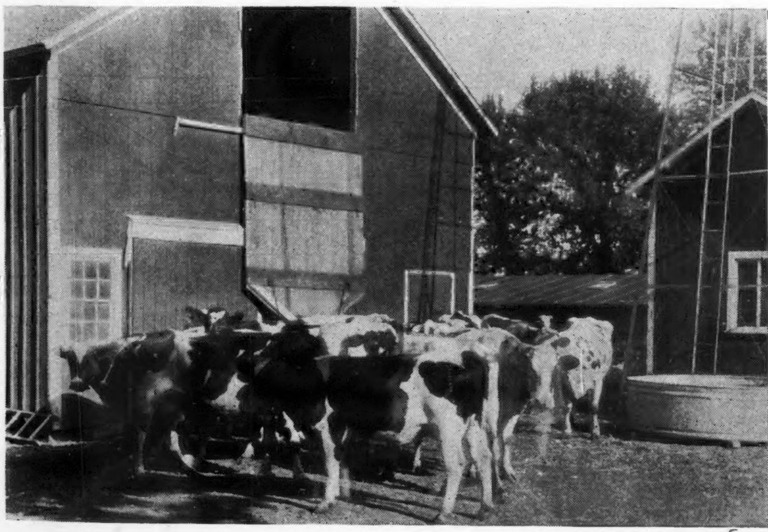
We think of the automobile industry as an industrial giant, but we are part of one even larger. Obviously there are many problems of an engineering character wherever so much material is processed and converted. That these problems exist and that they are engineering problems is just now beginning to be realized. It seems to me to be a good time to survey our situation with respect to the supply and qualifications of future dairy engineers and make suggestions as to supplying any deficiencies which may exist.

Training and education are practically synonymous words. Either means the process by which one acquires the knowledge and skill he or she possesses and employs in his daily life and occupation. Garfield, I believe it was, said his idea of a liberal education was to sit on one end of a log with Mark Hopkins on the other. There is no denying the value of an education thus painlessly absorbed. Neither is there doubt of the value of an education acquired in the school of hard knocks; it is the way many of today's dairy engineers acquired theirs. We have in our industry many individuals who, by the extent of their experience and the scope of their services and responsibilities, may properly be considered dairy engineers. Some of these men have followed some recognized and systematized course of study and are entitled to append a section of the alphabet after their names. Others are without that privilege.

I believe the fact that opportunity has been open to all is in large measure responsible for the remarkable growth and development of the business, and I would not like to see this freedom of opportunity curtailed. It is but natural, however, that, as our problems and responsibilities become larger, the men who are entrusted with them must have known qualifications. The shortest route

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition, at Toronto, October 1929.

[2]Director of research, The Creamery Package Co. Assoc. Mem. A.S.A.E.



Within a generation dairy product manufacturing has been transformed from a farm into a factory enterprise. While the raw material comes from the farms, the manufacturing problems are no more those of agriculture than are the miller's problems, for example

to the acquisition of the necessary qualifications is to pursue a systematized course of study and training if such be available.

It seems obvious to me that future developments will be largely along engineering lines. The technique of dairy product processing and manufacturing is pretty well fixed. It hasn't changed greatly in a generation. About all we do differently than we did a score of years ago is to concentrate and process more of the product in one place. The changes are in the mass and involve physics; hence, they come within the domain of the engineer. Engineers will be called upon to devise the means for transporting, converting, processing, manufacturing and distributing oceans of milk in a more economical way than it has been done heretofore. To carry out this tremendous task, we need trained men.

Our situation isn't greatly different to that through which many other industries have passed—mining, for example. Back in 1849, and for many years afterward, mining was a hit-and-miss proposition. The prospector went into the hills and dug a hole or broke off some likely appearing pieces of rock and had them assayed. With luck, the prospector became rich and wound up as United States senator. Without luck he went finally to the poorhouse.

Mining isn't conducted in that way today to any great extent. Mining corporations have geologists, chemists and engineers on their staffs. The geologist and chemist tell them where the metal is and how much of it, but it is the engineer who gets it out at a profit. One such engineer has done it so well and operated over so much territory, combining with his engineering ability such other qualifications that he is today the President of the United States of America.

A mining engineer is not merely a mechanical engineer—a conserver and director of energy. He has a specialized training in the processing of ores. I feel we need just such specialized training in dairy engineering—training which covers all the fundamentals of dairy product processing, but emphasizes the physical aspects of the job.

I compared our industry as to size with the automobile industry. We can find other points of similarity. One of the points is obsolescence. In the automobile business, obsolescence operates not only with reference to the product, but to the equipment used for manufacturing. It is often said "They don't build cars as good as they did." Charles F. Kettering of General Motors in a recent article pointed out that, if a $2,000 motor car ten years ago had been sealed in glass so that it would not deteriorate physically, the car would nevertheless lose value at the rate of about $200 per year so that today it would be worth just about its junk value. The lesson Mr. Kettering draws is that the motor car industry gives much more for the money today. It isn't wear or depreciation which has lowered the value of the 1919 automobile; it is obsolescence.

We have this same factor operating with reference to dairy equipment. Now and then someone complains of the short life of dairy machinery. As a matter of fact, it probably lasts too long. The real reason for short-lived equipment is improvement—called for by new conditions. Economic changes make it imperative, seemingly, that larger quantities of material be handled in one place at a smaller man-hour expenditure. To work this out requires engineers rather than dairy technicians.

Here is an example of this concentration: In Iowa, 435 creameries made 133 million pounds of butter in 1923. In 1928 there were made in 464 creameries 196 million pounds, an increase of about 37 per cent per plant. The output per plant is likely to increase rather than decrease, which will emphasize the need for engineering service.

. . . . As our problems and responsibilities become larger, the men who are entrusted with them must have known qualifications. The shortest route to the acquisition of the necessary qualifications is a systemized course of study and training.

So far we have merely sketched in the background of the picture I am trying to present. Summed up in a nutshell it seems to me the situation today and in the near future, calls for the engineering type of mind, for men who can take the technology of the laboratory and the experimental plant, expand the operations a thousandfold and retain the integrity of the process. To do this the engineer must know the whys and wherefores of the process itself, which, in my opinion, calls for some such specialized training as the mining engineer receives in his chosen line.

Where is this training to be had? I have made no exhaustive investigation, but I did make inquires of several of our leading universities where both engineering and agriculture with dairy manufacturing are taught and am unable to find that any of them offers a four-year course leading to a degree in which the fundamentals of a dairy engineering course are to be found. Of course, a bright young man with his eyes on a career in dairy engineering could doubtless carve out a course for himself which might answer, but such a man is exceptional and will probably succeed anyway.

But up to now there has been no attempt, so far as I am able to determine, to outline a regular course of study. Perhaps it can not be done, but it certainly seems worth considering. Fortunately most of our land grant colleges couple agricultural science and the mechanic arts. However, they keep the courses of instruction pretty well separated. There is some attempt to teach a little engineering to the dairy students, but none to teach dairying to an engineer. Such courses are at least seven-eights dairy technology and one-eighth or less engineering. I hazard the guess that a dairy engineering course should be made up of about three parts engineering and one part dairy technology. I believe the engineer will acquire the necessary knowledge about dairy science easier than the other way about. In short, I believe the engineering type of mind is necessary to the making of a diary engineer, hence, the emphasis in training should be in that direction.

There are present here several dairy instructors. I do not want them to feel for one instant that I disparage the quality, the quantity or the essential usefulness of their work. The remarkable development in our industry to date is due largely to their investigations and instruction. They have shown and are showing the way to quality products. But it is the province of the engineer to apply the principles laid down in the laboratory on the scale called for by modern industrial organization. I am sure we would like to hear from educators as to what might be done to combine engineering and dairy technology into a course of training which will develop dairy engineers. In my opinion, there is need for such a combination and men so trained will not lack for opportunities to put their knowledge into service.

In closing, it may be in order to suggest that in the event this meeting agrees with me in principle, as to the need for recognized training, that a committee be appointed to consider the subject with a view to encouraging the offering of such courses.

Engineering in the Modern Dairy Plant[1]

By J. J. Mojonnier[2]

IN ORDER to supply better dairy products at prices within the reach of all there are three engineering needs in the modern dairy plant that are outstanding.

1. Standardization. The first of these is standardization. In appying standardization to the modern plant, it is most important to standardize the factors that make for improved quality. Each of us know that when butter is real good, we spread it on thicker. When milk is good, we ask for a second glass. When ice cream is real good, we enjoy the second dish as much as the first.

The public today demands good dairy products. They have the right to expect good dairy products. Our great problem is to study and find out how to produce exactly what the public wants. We can then standardize our methods to secure this result.

Standardization of quality extends clear back to the dairy farm. If the milk supply from the farm is not first class, it is next to impossible to get a good finished product. There is too great a difference today between the finest quality of fresh milk and ordinary milk that is produced. It would seem possible to find how the best milk is produced and standardize operations at the farm so that all of the milk would be of the same fine quality.

For example, a dairy engineer recently told me of his method of winning first prize in a butter-scoring contest in Minnesota. He went to the farm where he obtained the milk from which the butter was to be made. He selected the feed for the cows. He milked the cows himself and cooled the milk properly. He cleaned the separator, separated the milk and churned the butter with the utmost care. He won the first prize for his butter on all counts, the first year and second year. Then someone else found out exactly how he did it, and the third year he had some competition. This shows, however, that by following simple methods it is possible to obtain dairy products of the highest quality. There is a great field for close cooperation between the dealer in dairy products and the farmer who supplies his milk to produce milk that is just right.

Factors that particularly need study and standardization are (1) the sterilization of the milking utensils and (2) cleanliness in milking.

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition, at Toronto, October 1929.

[2]Secretary, Mojonnier Brothers Co.

The Proper Cooling of the Milk at the Farm. Too much care cannot be exercised in getting the milk from the farm to the plant at the proper temperature and in clean sterilized cans. These are all factors that can be standardized.

It is possible to receive fresh milk from the farms that is practically perfect and to handle this in the plant in such a way that the flavor and quality is spoiled by improper plant methods.

One of the most important factors in the plant that needs to be kept in perfect control is the method of cleaning all of the apparatus with which the milk comes in contact.

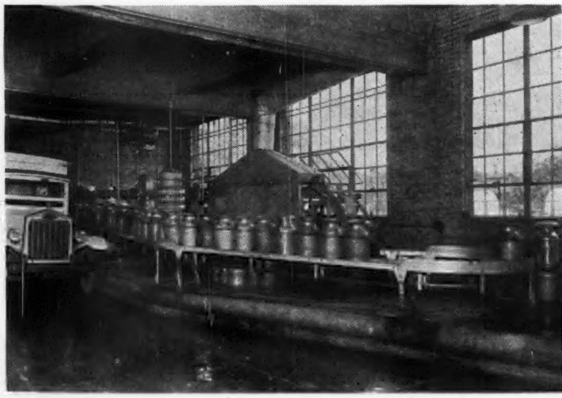
It is possible to work out a definite standardized routine for cleaning and sterilizing dairy machinery that will absolutely eliminate any contamination. For example, one company has developed the method of filling pasteurizers with water after the equipment is thoroughly cleaned in the regular way. In this water they put chlorine solution, and then run this through the entire system, over the coolers, through the filler, allowing it to flush out on to the floor. After this operation the equipment is thoroughly steamed. This method has enabled them to reduce the bacteria count to a minimum.

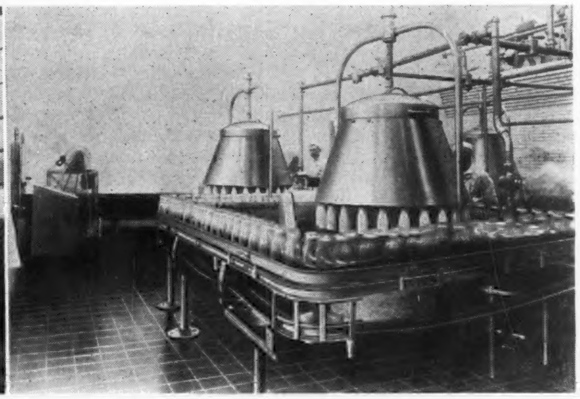
The greatest care should be exercised in selecting equipment that does not subject the dairy products being handled to surfaces that can not be properly cleaned. The stuffing boxes of coil vats and poorly made seams should be avoided if possible.

Another factor that influences the flavor and quality of dairy products is the method of heating in the pasteurization process. It is possible to completely spoil the flavor of milk and ice cream mix by having too great difference between the temperature of the heating medium and the product being heated.

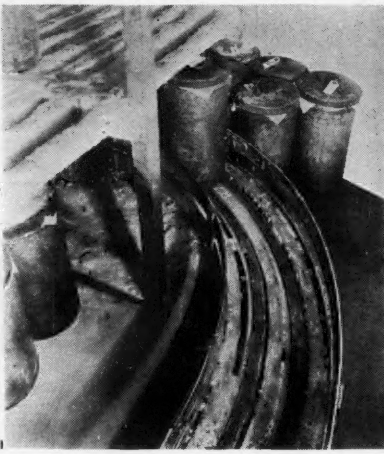
The precision heaters now being introduced are a great step ahead in standardizing methods of heating. Quality is often impaired by improper temperature control and careless handling after the product leaves the plant. There is distinct need for standardization of methods for getting the dairy products from the plant onto the table in the best possible condition.

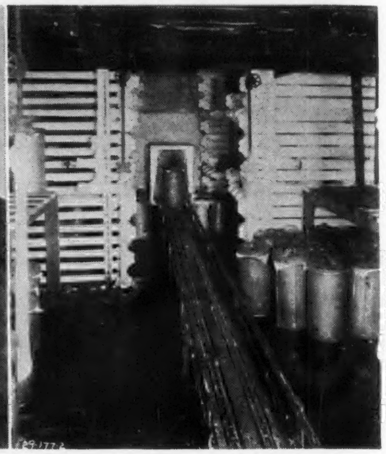
The modern dairy plant needs to standardize by accurate methods, the butter fat and total solids in all dairy products, both purchased and sold. The condensed milk and ice cream manufacturers have learned the cash





(Left) Receiving room of the Wieland Dairy Company, Chicago. By the time the truck driver has his fitieth can unloaded the first clean empty can is at hand ready to be loaded on. (Right) Mojonnier bottle conveyor and vacuum bottle filler in the plant of the City Dairy Company, Toronto





(Right) Ice cream can conveyor in the plant of the W. J. Shedd Company, Chicago. Cans are conveyed through a can-size door and around and under the brine shelves. No trucks are required in the hardening room. (Extreme right) Another view in the same plant. The conveyor may be loaded, started and unloaded at the next point by the same man

value of exact methods of testing. In many cases the savings by accurate standardization have meant the difference between success and failure.

These same accurate methods could be extended to advantage in the fresh milk, butter and cheese industries. Here is a new source of profit not to be regarded lightly.

There is no substitute for exact standardization and scientific control in the modern dairy plant. This is necessary at every turn to protect products from teat to table.

2. Simplification. A second great need of the modern dairy plant is simplification. There are great possibilities in simplification of the plant itself, as well of the equipment in the plant.

The demand for good dairy products has grown so rapidly that it has been hard for the plant and equipment to keep pace with the demand.

Many plants are split up into a multitude of separate departments. This involves a foreman for each department, more labor and far more difficult supervision. Fewer departments mean fewer foremen, better foremen and better results. The fewer the men in a department or a plant, the easier it is possible to introduce technical control, and the easier it is to fix responsibility.

Where the plant is located away from the railroad, where loading and unloading facilities are unsatisfactory and costly, where departments are too great in number and where obsolete machinery is in use, it has been found again and again that it pays to find a building site where these conditions can be corrected and to build a new plant properly designed and equipped with the most approved modern equipment.

Striking examples of this fact are shown in the new Hood plant in Boston, the new Anheuser Busch Ice Cream plant in Long Island City, the Wieland plant in Chicago, the Western Dairy Products plant in Seattle, the St. Louis Ice Cream Company in St. Louis, and dozens of others. Such plants soon pay for themselves through the confidence instilled into the minds of the consuming public and through the actual cash savings made through simplified operation, technical control and scientific management.

Modern machinery is helping in a large measure to simplify plant operations. With a well-designed conveyor system often a costly defect in plant layout can be corrected, and men can produce far more work with less labor. Older plants may at comparatively small cost be made into modern production plants.

We need to simplify dairy machinery. Every effort is being made by the designers of dairy machinery to produce dairy machinery of simpler design. Every effort is being made to make it foolproof, easy to clean and free from any mechanical trouble. We are striving to produce equipment that will do more work in less space. This makes possible a smaller investment in plant space and the combination of departments.

Our greatest responsibility in designing dairy machinery is to fit the machine to the work. We must make sure that the dairy products being handled are improved by the use of the machine.

The modern dairy plant needs modern machinery. There is no substitute for good machinery. No investment pays dividends so satisfactory as an investment in well-designed dairy machinery.

3. Cooperation. The third great need of the modern dairy plant is cooperation. Great work is still to be done in the modern dairy plant. Many problems are still to be solved. Engineering skill and wonderful machines are of no avail without close cooperation between the dairy engineers of our dairy plants on the one hand, and the dairy engineers of our machinery companies on the other. There was a time, when a dairyman wanted to sell milk, he built a plant, bought a pasteurizing vat, cooler, filler, a few hand trucks, and then hired a large number of men; and he was pretty well set up in the milk business. Sometimes he succeeded; sometimes he failed.

Today the building of the large modern dairy milk plant is an engineering feat no less than building a bridge spanning the Hudson or a tunnel through the mountains.

Each operation in the plant must be timed to a nicety. There is a relation between the rate of unloading cases on the platform conveyors and the capacity of the pasteurizer and fillers. There can be no guess work. There can be no weak link in the equipment. The entire plant is one big machine. The building of such a plant requires intense thought and study.

A typical example of cooperation is illustrated by one example in our own experience. We were called in to help in the designing of a combination milk, ice cream and butter plant. Plans had been worked out to have three separate departments, with a manager in charge of each department. By careful study it was found possible to lay out the plant so that one good technical man could manage the three departments. In this plan instead of using three managers and thirty men as originally planned, they are handling their entire plant with only one manager, eleven men and five girls. This result could not have been obtained by the dairy engineer alone, but was obtained by the close cooperation of the dairy engineer in charge of the plant and the dairy engineer of our own organization.

We dairy engineers cannot expect to succeed unless we can help the owners of dairy plants to introduce methods that will improve quality, effect real economies, and increase their net profits. Our success is dependent upon the success of those to whom we are of service.

Research in Dairy Engineering[1]

By R. L. Perry[2]

BEYOND a few fortunate exceptions, research of a dairy engineering nature has been quite spasmodic, apparently having been forced from time to time in unrelated and distinct problems by the immediate difficulties of some branch of the industry. At present only a few institutions are carrying on projects having a direct bearing on dairy engineering. A rough analysis of projects listed reveals major attention to testing, analysis, bacteriology, factors influencing quality, routine production methods, with some few studies on economics, management and equipment. Most of the equipment studies are handled from the viewpoint of the comparative effect of various types of present equipment upon the product rather than of determining factors which will govern the design of effective equipment.

The lack of engineering work has not been caused by a lack of engineering problems. The Committee on Dairy Engineering of the American Society of Agricultural Engineers has a list of some hundred or more problems, the solution of which would well reward effort. These might be grouped about as follows:

1. Plant equipment design, for example, layout for line routing
2. Plant building design, for example, durable floors
3. Continuous processing in ice cream freezing
4. Heat transfer, especially in pasteurization and cooling
5. Regenerative heating and cooling
6. Direct-expansion refrigeration
7. Corrosion reduction, with regard especially to effect on product
8. Special equipment problems, for example, the milking machine
9. Products handling.

A consideration of possible reasons for inadequate dairy engineering research may assist in finding remedies. Dairying as an industry is a recent development. Data on products and processes has been lacking or fragmentary. Until a considerable volume of strictly dairy information was accumulated, dairy workers quite properly had their interest in supplying the demand for this. Because of the same lack of data, engineers were not attracted to work in this field, but preferred to do work of an engineering nature where required data was available rather than to do poor dairy engineering work or turn into dairymen. For example, the engineering difficulties of a continuous electrical pasteurizer have been solved, yet the equipment is not being readily received by the dairy industry because data regarding its performance from a dairy standpoint is considered by some to be inadequate. In general, however, engineering has as usual followed the primary development of the industry rather than led it.

More recently men who have begun to do effective work in dairy engineering research have been attracted by industry. In addition while trade associations were fostering or aiding in the guidance of research on their particular problems, there has been no similar agency to sponsor dairy engineering research. At present a very large part of what is done is being carried on by Committees on Relation of Electricity to Agriculture, who, although they are doing excellent work on farm dairy cooling and dairy sterilizers in particular, are interested in only one phase of the problem. The dairy equipment manufacturers deserve credit for assisting in what dairy engineering research has been done, in addition to helping in much straight dairy research.

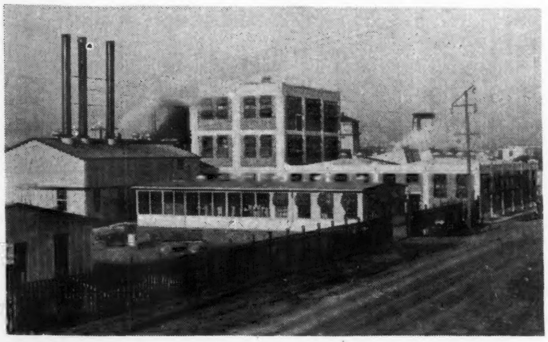
As knowledge of dairy products and processing increases, quality becomes more nearly uniform, and competition becomes based on cost of production rather than upon quality. In addition the industry must increase its production per man-hour if it is to keep pace with other industries in financial return. The scale of operations is growing, making engineering methods more attractive.

The growing demand for dairy engineering places two demands upon dairy engineering research. In the first place, as the dairy industry needs dairy engineering methods and information, it will also require men who can use the information and plan the methods. The condition pointed out by Wickenden before the 1928 meeting of the American Association for the Advancement of Science will occur in the dairy industry unless the danger is recognized and steps taken to forestall it. Any individual concern is more interested in securing able men for its own use than in directing their activities at the experiment stations, but to remove too many will stifle the training of others.

The second demand on dairy engineering research is the obvious one, to supply data for specialists practicing in the industry. One research man can develop data for many users. Much of the work in the industry will be of a routine design nature, but the basic data must be known, and few are in a position to determine their own.

Having noted the needs, what are the possibilities? The great value of adequate research in dairy engineering is difficult to overestimate. As suggested above, the dairy industry is approaching a position where it can use engineering methods effectively. It is not necessary to point out the familiar examples of what engineering has done in the electrical industry, nor what it is doing at present in the industry of agriculture.

An example or two may show the trend. The advantage of sterilization of utensils on the farm has been recognized by dairy authorities for a number of years. When the requirements from a dairy standpoint were determined, then engineers developed equipment which could be used economically and effectively. Again, independent studies of mechanical can washers were recently carried out by two experiment stations. Both of these considered design and operation of the present types



A powdered milk factory which makes a valuable product out of milk solids other than fat. Dairy plant building and equipment design demands the attention of dairy research specialists

[1]Paper presented at meeting of the Pacific Coast Section of the American Society of Agricultural Engineers held during the Pacific Slope Dairy Exposition at Oakland, Calif., November 18, 1929.

[2]Junior agricultural engineer, University of California Agricultural Experiment Station. Jun. Mem. A.S.A.E.

of machines. The result of one study was directions for operation of present machines. The other, an engineering study, secured similar results, and, in addition, data on cost of operation, suggestions for more economical operation, and a number of valuable factors for improvements in design.

The research worker in dairy engineering will be in position to accomplish a great deal. He has at his right hand a vast supply of engineering data covering subjects from materials to disposal of waste, and from heat to cold. At his left hand is an increasing store of dairy data. Much of this is not available to the routine engineer in industry for the details of the application of one to the other must be worked out.

Having seen that dairy engineering research will pay attractive dividends, how can it be best promoted? Several steps must be taken. The interest of those who will benefit must be focused, a comprehensive program visioned and adopted, men properly trained secured, and funds enlisted.

In regard to the first, there is no lack of interest at present, yet what there is is haphazard, and each individual's primary difficulties are obscuring his vision of the problems he has in common with other branches of the industry which lend themselves to engineering analysis.

In developing a comprehensive program organization is essential. There are a number of groups at present who represent all the various branches of the industry. Each of these can contribute guiding beacons, yet an impartial light reflecting all of these is necessary to show the best course.

The steps of securing men and financial backing will follow readily if the first two steps are well taken. It must be observed that there are only a few institutions staffed or equipped to carry on dairy engineering research work. The program must be developed slowly as its fruits prove its value. The primary need is to gain a true picture of the field as a whole, then to promote that part of the work which is most urgent and which will yield the best return. With the value of the work well acknowledged, the more baffling problems may be attacked.

SUMMARY

1. Little dairy engineering research is being carried on in the agricultural experiment stations
2. Conditions are growing more favorable for effective work
3. Good work should yield satisfactory returns
4. To be effective a comprehensive program must be visioned and carried out.

Looking to the Future of Dairy Engineering[1]

By John W. Ladd[2]

THE value of a free exchange of ideas and knowledge between engineers has been demonstrated in other lines. An outstanding illustration of this is in the public utility field. Their engineers are constantly meeting to study the problems and needs of their properties, and it is interesting to note that there is a definite relationship between the engineering ability of any given public utility and its ability to finance additions and enlargements to its properties. I have one public utility in mind that never has any trouble in placing its securities, and its president has told me that one of the major reasons for this is because of the high calibre of engineers that are directing this particular concern's progress.

The dairy industry is looking to just such men as you for new ideas. They can rightly expect it from you because you combine a knowledge of dairy products and their processes with a technical knowledge of an engineering nature. It is unfortunate that we do not have a full four-year dairy engineering course offered by our universities. As it is we must rely upon you men very largely to anticipate the dairy industry's needs and to develop ways and means of meeting them.

Going back to the public utilities for an illustration of this, I happen to know that six public utilities are putting up money to carry on experimental work on a new way of generating electricity. Many of you remember the German ship that came across the ocean and made the return trip on its own power, propelled by two revolving stacks. Commercially I don't think that ship was a success, because, we want faster transportation, but the idea was right. Now the public utilities have an idea of harnessing the wind and taking from it its power. Visualize a large circular track with cars running around, each car carrying one of these large stacks. A generator takes the power from the moving car to a center and transmits it over high tension wires to various centers. It seems almost ridiculous, but through their engineers, and after going into a very exhaustive study of this method of generating electricity, the engineers find that it offers practical possibilities, and it seems as though it is going to work. It just shows you what is taking place in other industries, and I am hoping that in the dairy industry we may eventually have the same sort of cooperation.

I can remember, and some of you probably have been in this business long enough also to remember, some old catalogs issued by dairy machinery houses, the back pages of which were devoted to typical installations of cheese factories, creameries, etc. We used to go in and sell a 12-horsepower boiler, a 6-horsepower engine, a small churn, a vat, a bit of lineshaft and belting, and a few more odds and ends for $1100.00 or $1200.00, to make up a creamery outfit. Just compare that to the equipment of the present day. You could hardly get the first piece of equipment for that price. So we have been going through an age of development that is greater than any of us realize, but I think we have reached a point when we must take a more orderly program, and I believe that program covering research, application, design and principles to be used in the manufacture and use of machinery will be more intelligently guided by your body.

There is one thought I want to leave with you, that is, that in forming an organization you should proceed carefully. I want you to bring the plane of your organization to a point high enough so that the industry at large will recognize it. Keep your requirements such that anyone that belongs to it carries a certain distinction, and then, too, remember that your accomplishments will come from a free exchange of ideas, and to carry on a free exchange of ideas it must be necessary for you all to give as much as you take.

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition at Toronto, October 1929.

[2]Vice-president, Cherry-Burrell Corp.

Properties of Dairy Products in Relation to the Design of Dairy Machinery[1]

By O. F. Hunziker[2]

THE product we are dealing with in the use of dairy equipment is an exceedingly complex one. Fundamentally the properties of milk may be grouped under three main heads; namely, physical, chemical and biological. The details of these properties are not constant, they vary continuously. No two batches of milk are exactly alike, physically, chemically or biologically. These variations are due to conditions that are not under our control, such as breed, individuality, period of lactation and feed of the cows, climate, and the care of the milk on the farm. The majority of the differences in the character of the properties of milk are not even apparent or noticeable when the milk or cream arrives at the plant.

As far as the design of the equipment is concerned, its desired effect on these properties may be to preserve them or to completely alter them. This must of necessity depend on the kind of product we intend to manufacture and the nature of the essential marketable properties of each type of manufactured product. In other words, each of the fundamental groups of properties of milk, the physical, the chemical and the biological—must be taken into consideration and the product must be so handled as to cause these properties to reappear in the manufactured product in a form that conforms with the marketable properties desired and demanded.

Take the physical properties of normal milk, for instance. According to the colloid chemist's conception, milk is an emulsion of fat in hydrated colloid, with milk sugar and mineral salts in solution. For the purpose of our discussion here milk is, roughly speaking, an emulsion of fat, casein and some mineral salts in a watery solution of milk sugar, albumen and milk ash. In the manufacture of market milk, condensed milk, evaporated milk and ice cream, our effort must be directed toward the preservation of this original emulsion. The market demands that the fat and the casein in these products remain in emulsion and suspension. If the milk oils off or churns, or if the casein forms an insoluble curd, visible to the eye, the product loses its market value. We must therefore have facilities in the form of suitable equipment so to handle the milk as to preserve this emulsion, or emulsion-retaining property, in the manufactured product.

In the case of market milk the emulsion must be in two separate forms in the same container — milk and cream — and there must be a satisfactory cream line. In butter manufacture the emulsion of fat-in-skimmilk as represented by milk and cream must be changed to an emulsion of skimmilk-in-fat as represented by butter. This change is effected by the churning process. In the manufacture of cheese the emulsion is broken by the formation of the curd. In ice cream we must guard against such crystallization of the milk sugar as would make the ice cream sandy. In sweetened condensed milk the concentration is so great that copious sugar crystallization cannot be avoided. Here sandy milk and objectionable sugar sediment in the tin are prevented by encouraging mass crystallization in order to reduce the state of supersaturation to a state of saturation, while the crystals still are too small to make a sandy product.

I mention these physical features at this point merely in an attempt to illustrate the fact that in the handling of milk the effort often is to change the form of its original properties, quite as much as to preserve them. What I have said of the physical properties is equally true of the chemical and biological properties.

In the design of dairy equipment we must, therefore, take into consideration the particular marketable properties desired in the finished product. The marketable properties of the finished product deal chiefly with such items as wholesomeness, flavor, keeping quality, body and texture, color. Let us consider these items briefly.

Wholesomeness. Since we are dealing with a food product, wholesomeness is obviously the first essential. Its bearing on the design of equipment is confined chiefly to the sanitary aspect of the equipment and to facilities for temperature control. The features of special importance here are well known to you. They have to do principally with ease of access, for cleaning and sterilizing, to all parts and surfaces that come in direct contact with the milk product. They include also absence of

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition, at Toronto, October 1929.

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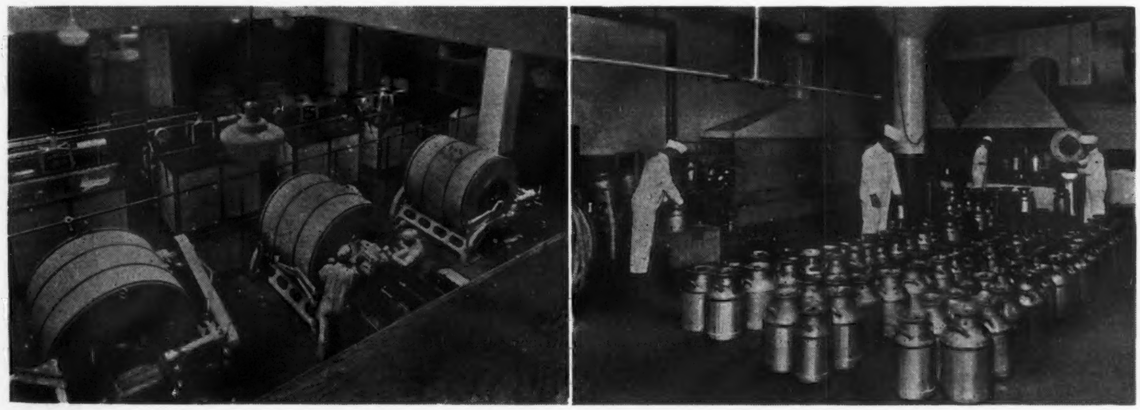


(Left) The churn room of the Blue Valley Creamery Company, Chicago. (Right) Washing cream cans in the same establishment

conditions that cause the adherance of remnants of milk, such as rough and porous surfaces, pockets, crevices and open seams. Wooden surfaces, because of their porosity, are undesirable; they are difficult to keep clean and sterile, and very prone to become foul. They should be eliminated wherever we can get along without them; they are as yet indispensable, however, in the construction of churns. Facilities for heat distribution and temperature control, especially in pasteurizers, are further important as they have much to do with the efficiency of pasteurization. Most of these essentials for sanitary equipment are intimately related not only to wholesomeness but also to flavor and keeping quality of the dairy product.

Flavor and Keeping Quality. These two important requisites of a saleable dairy product are related to several factors in the design of dairy equipment. I refer here particularly to such items as material of construction, sanitary aspect, and facilities for temperature control.

It is now well established that certain metals, when in contact with the milk product, yield salts that are capable of jeopardizing the flavor and keeping quality of the dairy product, while other metals are practically or completely harmless in this respect. Most metals are somewhat soluble in milk products, forming metallic salts. The salts of some metals, such as of iron and copper for instance, have so intense a metallic taste that their presence in the dairy product taints the latter with the same objectionable flavor. Some metallic salts in addition incite oxidation and catalysis, causing progressive flavor deterioration. Iron, zinc, galvanized iron, copper, and copper alloys, such as nickel silver and to a lesser extent Monel metal, belong to this group. In the construction of dairy equipment these metals should be avoided as far as their use for surfaces that come in direct contact with dairy products is concerned.

On the other hand, such metals as tin, properly tinned copper, nickel, chromium-nickel steel, and aluminum are known to be harmless, or nearly so, to the flavor and keeping quality of dairy products. Nickel has not shown itself entirely negative in high acid products, such as acidophilus milk, and it is unsuitable also for cheese vats, as contact of the cheese curd with nickel surfaces tends to color the cheese green. Tinned copper is not so well adapted for heating surfaces in pasteurizers, as the tin coating soon disappears from the surfaces due to the friction and strong alkalies generally used to remove burnt-on remnants of milk solids. The principal disadvantage of tinned copper lies in the poor quality of the tin coating. Its short life necessitates frequent retinning, which is costly. The tin coating of the retinned copper is usually of better quality than the original tin coating on new equipment. The short life of the tin coating in new equipment suggests that no improvement whatsoever has been made in the tinning of copper within the last quarter century.

The design of dairy equipment from the sanitary aspect constitutes another very important consideration with reference to the properties that control flavor and keeping quality. Let us consider for a moment the milk and cream shipping can. Its sanitary condition is one of the fundamentals in the control of quality in dairy products. It has probably as much to do with flavor and keeping quality of the finished product as anything that happens to the milk product in the factory. A can that is so constructed that it fails to respond satisfactorily to the routine cleaning, steaming, and drying process is a menace to the industry. Cans with unflushed seams, cans with loose shoulders, cans that are rusty, will be foul smelling upon return to the farm in spite of the most efficient washing they can receive at the plant. Milk and cream cans should really be seamless. The rusting obviously depends much on the cleaning, steaming, and drying the can receives. Aluminum cans are far more satisfactory in this respect than tinned steel cans.

The mechanical can washer has been a tremendous factor in improving the sanitary condition of the shipping can. The manufacturers deserve unstinted credit for the great service which they have rendered the industry in the form of these can washers. Most can washers on the market now are so constructed that the various jets may be removed readily for cleaning and it is absolutely necessary to do this daily in order to insure proper functioning of the machine. If I may be permitted to offer a suggestion as to where further improvement in its mechanism might be of great assistance, I wish to call attention to the need of better control of the strength of the alkali water and of better drying of the cans.

As the machine now is, there is no assurance that the alkali water is maintained at the proper strength throughout the day. This phase is not sufficiently automatic to make sure that each can receives a real alkali wash. And yet without the help of an alkali solution of reasonable strength, there is little chance for complete removal of grease and curd. Mechanical improvement that will insure uniform strength of the alkali solution will be most welcome to the user of the can washer.

The matter of dryness of the can is even more important, for just as sure as the can is damp when it is sealed, just so sure will it be bacteria laden and foul smelling by the time it arrives at the farm.

Why should the can be damp? The can washers finish off with one or more hot air jets, and when the hot cans leave the washer they are apparently dry. However, if they are then sealed they are apt to be damp before they leave the factory. Why? Because the hot air in the dried can is surcharged with moisture, and if the can containing that saturated air is sealed, the moisture will precipitate on the inside of the can upon cooling.

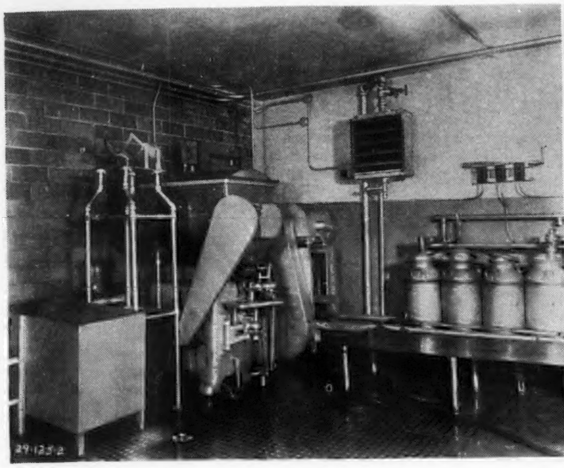
But why is that hot air in the can so extremely high in humidity? The fault does not lie with the machine itself, but with the way it is installed. In the great majority of installations the hot air fan draws its air supply from underneath the can washer where there is free steam and water.

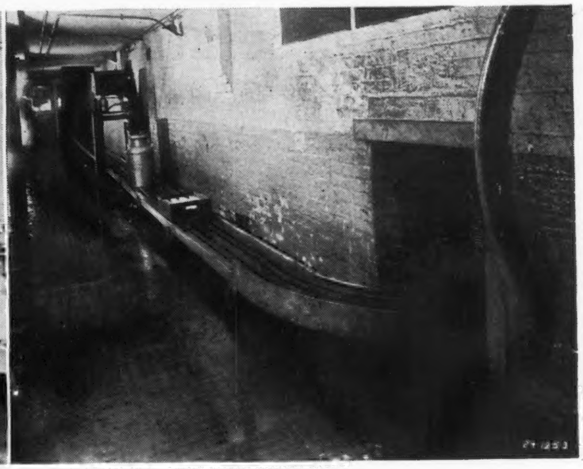
In short, when we install the can washer we thus overlook this very important requirement for efficient operation—the dryness of the hot air supply. Whose fault is it? It surely is our fault as users to permit such installations. But likewise the can washer manufacturer is neglecting an immense opportunity for valuable service by not providing conduits of sufficient length to draw in dry air, securing the air supply from a dry room within the plant or even from without the factory.

Great strides have been made in the perfection of the sanitary features of such important equipment as pasteurizers, coolers, holding tanks, ripeners and the like. As a whole, this type of equipment has reached a degree of perfection that is highly satisfactory. There is still some room for improvement of flush valves on pasteurizing vats and of the submerged glands in horizontal coil vats.

In the creamery the one piece of equipment that is most fundamental—the churn—has remained the most antique from the standpoint of its sanitary status. Through the engineering ingenuity of the fabricator the gear drive in many of the churns has reached a most admirable state of perfection and this feature has been of very great service to the butter industry. The interior of the churn barrel and the facilities for sanitary and convenient unloading, however, are phases that somehow have persistently evaded the march of progress.

It will probably be necessary to use wooden churn barrels for many years to come. The porosity of the wood appears to be indispensable to prevent butter from sticking, but wood is exceedingly difficult to sterilize and to keep in sanitary condition. There are some additional features in the barrel, however, that are undesirable and that could be readily corrected. The caps that clamp over the ends of the churn rolls are of galvanized iron. Any butter sticking to these caps, for even a shorter time than is necessary to unload the churn, shows a rank





(Left) A conveyor which places cans under the can filler and carries them on into the hardening room of the Bowman Dairy Company, Chicago. (Right) View of the conveyor on the loading platform of the same company

metallic and sometimes a fishy taste. The bolt heads in the ends of the churn, which are of galvanized or black iron and are capped with tin are unsatisfactory. These tin caps come off and are not infrequently found in the butter. Constructing the roll caps and the bolts of chromium-nickel steel, or of properly chromium-plated metal, would satisfactorily do away with these objectionable features.

The butter between the roll ends and the churn heads is prone to be ground into a discolored mass, often resembling black grease. It is conceivable that some ingenious improvement in the arrangement of the roller shaft bearings would correct this objection.

Some types of churns have rolls constructed of several pieces of lumber. The joints always open up, often after the first day's use, forming large and deep groves and cracks. It is physically impossible to satisfactorily sterilize such churn rolls. They collect remnants of milk solids and become ideal breeding places for diverse types of germ life. These rolls continuously seed the butter with molds and other injurious microorganisms. Such churn rolls are an abomination to the industry and their construction should be discontinued.

In the case of the long churn barrel the unloading still requires the tedious process of removal of the butter by hand. This is not only laborious, but it is insanitary, as the arms of the operator may and often do come in contact with the butter. Efforts have been made to cause the butter to drop out of the churn by setting the churn high enough to place a crate under the doors. This has not worked out satisfactorily because of the obstructing stave section between the doors. It is possible that the long barrel churn could be so constructed as to do away entirely with the obstructing stave section between the doors, so that when the doors are removed the door frame would present an unbroken opening over the entire length of the churn barrel. With such a churn barrel it should then not be difficult to cause the butter to drop out. The churn could then be installed at an elevation to permit the use under it of a long crate on casters with capacity to hold the entire churning.

Another phase of the equipment that influences flavor and keeping quality has to do with completeness of heat distribution and uniformity of temperature control. This phase determines to no small degree the efficiency of pasteurization and cooling and the operator's ability to control fermentations, both those desired and those that must be guarded against. For pasteurization the equipment should be so designed that all parts of the dairy product are subjected to the full pasteurizing temperature for the required length of time. In the case of the flash pasteurizer this necessitates by-passing facilities, as in most cases the first few gallons passing through do not get the full temperature. In vat pasteurization this involves consideration of the fluid in the nipple at the gate. This is now best taken care of by the installation of a properly functioning flush valve.

The matter of controlling fermentation as far as the equipment is concerned resolves itself largely into means of maintaining a uniform temperature and this in turn requires efficient insulation of holding vats and tanks. It is a fact that most coil vats do not hold temperature well. A change in temperature from evening to morning of 8 to 10 degrees (Fahrenheit) is not uncommon. This is objectionable and it seriously interferes with satisfactory control of fermentations. This defect could undoubtedly be readily corrected and the usefulness of vats materially improved by the use of either better insulating material, or thicker insulation, or both.

I have only barely scratched the surface of this important subject and its vast possibilities. I have briefly outlined some of the marketable properties of dairy products that should be considered in the design of dairy equipment and have referred to a few isolated instances where modification in design should prove helpful. Unfortunately, lack of time does not permit enumerating other similar instances nor mentioning those phases of equipment design that have to do with the physical side of the marketable properties of dairy products, such as body, texture, viscosity, foaming, color, etc., all of which are important.

I realize very keenly also that the matter of economy of production is a paramount issue, and that there are undoubtedly many improvements on the accomplishment of which the fabricator may have set his heart, but which he has had to temporarily table in order to maintain a workable balance between cost of fabrication and the ability of the industry to meet the price.

In conclusion permit me to voice my admiration of the splendid progress that has been made in designing and constructing better and better equipment and in making the equipment more and more foolproof every year. These successful efforts and splendid accomplishments on the part of the fabricator are a great challenge to the user of equipment to so direct its installation and use as to assure the achievement of its inherent purpose.

Temperature Instruments in the Milk Industry[1]

By R. E. Olson[2]

THERE is no need of entering into the reasons and necessities for modern milk-handling methods. There is no need to explain why all of the follower steps are important and why it is deemed good practice to chill milk immediately after milking and keep it cool awaiting transportation to the city dealer, to heat milk quickly to a pasteurizing temperature and to cool it suddenly, to place milk in a cold-storage room awaiting distribution, and to keep it cool until it is finally delivered to the customer. The ultimate consumer expects quality milk, though the growth of modern cities has increased the distance between the milk source and the ultimate consumer. The distance was overcome by modern transportation methods. The remaining time element was left to be solved by the milk industry.

With the creation of a distribution system, the industry found that a definite relationship exists between time, temperature and quality. For example, it is commonly known that other things being equal raising the temperature of milk shortens the time it will remain sweet, or the quality remain constant. Conversely, lowering the temperature, but not to the freezing point, lengthens the time a given milk will retain desired quality.

As urban growth introduces distance and the associated time element, and the time element in turn introduces and stresses temperature, making it one of the major phases of the modern milk industry, numerous temperature instruments have become necessary, such as industrial thermometers, index thermometers, recording thermometers, and temperature regulators. These instruments will be briefly described before considering their application as found in the industry, in the sequence which milk follows from the original source to the ultimate consumer. The following sequence indicates where the various temperature instruments are used: (1) Dairy farm in connection with sterilization and cooling; (2) transportation; (3) city milk plant in conjunction with receiving, can washing, pasteurizing, holding, cooling, bottle washing, bottle filling, and cold storage.

Any or all of the operations mentioned can be performed of course without temperature instruments. Instruments simply indicate actual happenings and maintain desired conditions more accurately and with a lesser expenditure of time than primitive methods. Operating without instruments, although possible, is as undesirable as trying to conduct business successfully in the present industrial era of rapid communication, high-speed transportation and uniform high quality-quantity production without modern scientific methods and equipment. Results can be obtained, but only with a tremendous cost of time, effort and loss resulting from non-uniform quality. Consequently, good practice has established, beyond a doubt, the necessity for temperature instruments.

A brief description of the four types of instruments; namely, industrial, index and recording thermometers, and temperature regulators, is necessary before considering the use of temperature instruments in the milk industry.

Industrial Thermometers (Fig. 1) are used to indicate existing temperatures and have numerous applications in the milk industry. In fact, their use extends to all types of apparatus in the operation of which heat is a factor. There are several major elements of construction which must be carefully considered in making a reliable instrument. The glass tube must be properly seasoned, so that the indications of the thermometer are permanently correct. It must be supported and packed in its metal case or housing, so that it will not break due to strains and jars which it may receive in ordinary use. Where the instrument may at times be subjected to temperatures beyond the upper limit of its range, that is, in sterilization, an expansion chamber should be provided in the bore at the end of the tube to prevent high temperatures breaking the instrument. The scale should be of sufficient length to permit of quick and accurate readings; with graduations at least 1/16 inch wide through-

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition at Toronto, October 1929.

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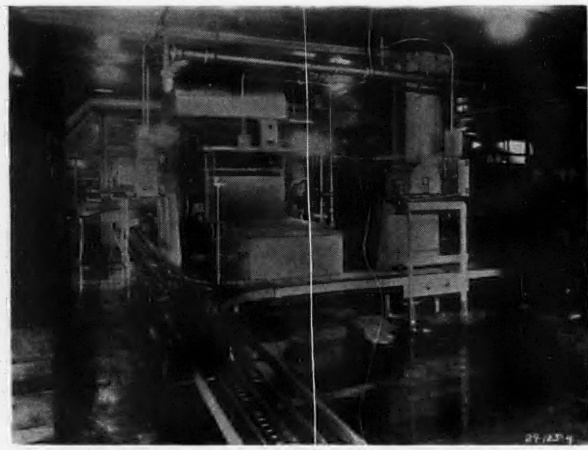
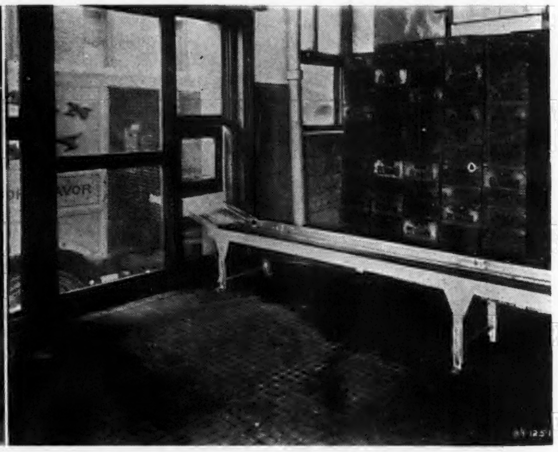




In the modern milk plant temperature is an important factor and temperature instruments indicate happenings and maintain desired conditions more accurately and with a lesser expenditure of time than primitive methods

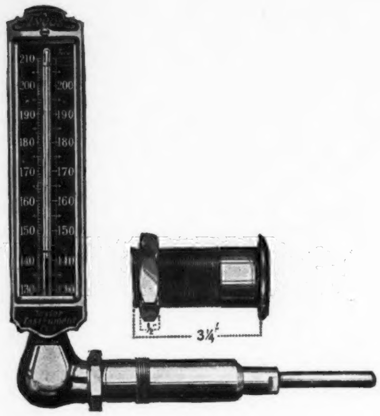


Fig. 1

Fig. 3

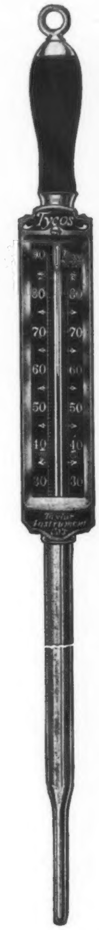


Fig. 6 (right)

Fig. 2

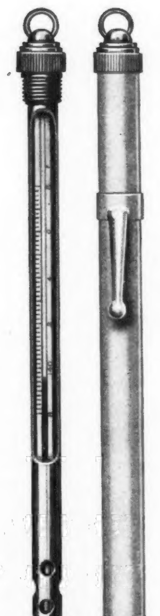


Fig. 5 (left)

Fig. 7 (above)

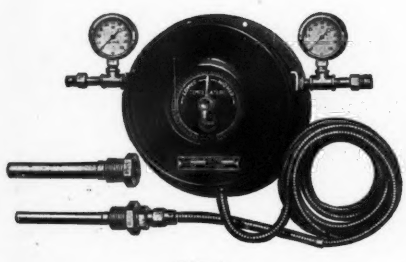


Fig. 4

Fig. 8 (right)

Fig. 1. Right side-angle thermometer showing taper seat on stem and swivel-nut of union connection. Fig. 2. Mercury actuated index thermometer with sanitary ferrule. Fig. 3. Recording thermometer with sanitary I.A.M.D. fitting. Fig. 4. Air-operated temperature regulator. Fig. 5. Pocket-type mercury-in-glass test thermometer. Fig. 6. Handled cold-milk inspectors' thermometer. Fig. 7. Index thermometer for can washers, bottle washers, etc. Fig. 8. Self-acting temperature regulator

out the cooling and pasteurizing range. Some milk ordinances require lines graduated directly on the glass tube at the critical pasteurizing temperature, such as 142, 143 or 145 degrees (Fahrenheit), as the case might be.

Mercury is most commonly used in thermometers, because of its sensitivity, although so-called alcohol-filled thermometers are used extensively at lower temperatures. In selecting a thermometer of this type care should be exercised to make sure that the filling medium in non-fading.

Finally, the stem, that is the part fitting into the apparatus, should be designed so that there are no crevices or threads exposed to and in contact with the milk, because the difficulties encountered in cleaning, offer an opportunity for unsanitary conditions. The bulb chamber, which contains the glass bulb of the thermometer, should be properly filled with a conducting medium, such as mercury, to insure that the thermometer indications follow rapidly and accurately any and all temperature fluctuations of the milk or water in which it is immersed. This type of thermometer is applicable to pipe lines, vats, jackets, etc. Wherever installed, the bulb should be so located that it is directly in contact with the milk or water, and in the path of good circulation. The parts of the thermometer in contact with the milk or water should, of course, be adequately protected against corrosion, which causes excessive deterioration. The industrial thermometer must of necessity be made in two distinct forms; namely, straight and angle stem, depending upon the location provided by the equipment manufacturers. In addition, various types of connections are necessary to facilitate installation in pipe lines, vats, water jackets and glass-lined tanks.

Index Thermometers (Fig. 2) can be used in place of industrial thermometers. This type of thermometer, resembling a pressure gage in appearance, is exceptionally easy to read and possesses another distinct advantage in that its dial can, for convenience, be located remotely from the point at which the temperature is being measured. The actuating element in this form of thermometer is known as a tube system, consisting at one end of a bulb which is inserted into the apparatus, and of a connecting capillary tube with a spring at the other end. In the form most widely used in the milk industry this tube system is filled with mercury under pressure, the expansion of which causes the spring to move. A pointer is attached to this spring by a suitable mechanism.

In order to withstand the hard usage the instrument may receive in milk plants, it is desirable that the capillary connecting the bulb and spring be exceptionally strong, that it be plated to withstand corrosive action, and that the case housing the mechanism be moisture-proof. Also it is essential that a convenient adjustment be provided for restoring the accuracy, should this become necessary at any time. This adjustment should be of such a type that it cannot easily be tampered with, and therefore preferably a seal should be provided. A further desirable refinement, if accuracy is to be obtained, consists in providing a means to compensate for fluctuating temperatures at the instrument case. The length of connecting tubing possible will meet practically every installation requirement. A vapor-pressure-actuated dial thermometer is also applicable for milk-plant machinery, but it cannot be made as sturdy as the mercury-actuated type, and the dial graduations are not uniformly spaced.

Recording Thermometers (Fig. 3) make a permanent record of temperature conditions. A graphic history of temperature and time is an acknowledged necessity in pasteurizer operation. A recording thermometer fulfills this demand and provides a permanent record of temperature with respect to time. The actuating element is identical with that used in a mercury-actuated index thermometer as just described. A pen arm replaces the pointer and a revolving chart is used in place of a dial. Here again it is desirable to have a moisture-proof instrument. The chart most commonly used has an overall range of 20 to 220 degrees, which is designed to serve three purposes, to record temperatures throughout the pasteurizing range where the chart is graduated in degree divisions at least 1/16 inch wide. The same chart shows sterilization and the cooling temperatures. A sealed pen-arm adjustment is also advisable for this form of instrument, and in fact is insisted upon by some milk ordinances.

Temperature Regulators (Fig. 4) are automatic instruments and are of vital importance in the milk industry. It is obvious that in addition to maintaining the desired temperatures, an automatic device will result in beneficial savings of labor and steam. Two types of regulators most widely used are the self-acting (Fig. 8) which, as the name implies, requires no outside motive force, and the air-operated (Fig. 4) which obtains its motive force from compressed air, usually at some constant pressure, such as 25 pounds per square inch.

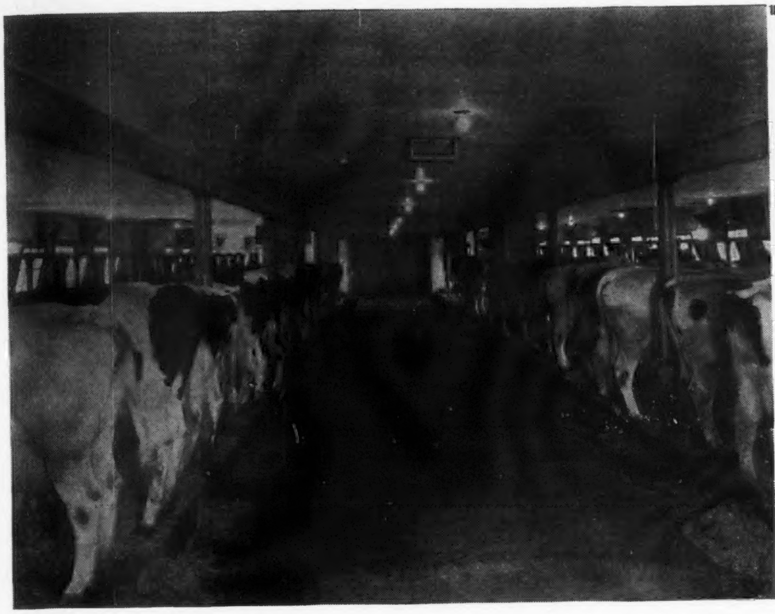
The air-operated type, in common with recording and index thermometers, contains an actuating element or tube system which permits placing the bulb in the apparatus to be controlled, the instrument proper being located at some remote convenient point. Temperature changes at the bulb cause an air valve within the instrument to increase or diminish the flow of air to a diaphragm-operated valve in the steam line. Thus the air opens or closes the steam valve, and heat is or is not supplied to the apparatus, as the condition requires. When operating under balanced conditions, the instrument causes the diaphragm valve to assume a position which permits a quantity of steam to pass just sufficient to maintain any desired temperature. Setting the instrument to maintain any desired temperature is easily accomplished by moving the pointer with reference to a graduated dial. Because of its inherent accuracy of operation and its long life, the use of this type of regulator is to be preferred.

The self-acting type of instrument can be used with satisfactory results, although experience has shown that on some types of apparatus its usefulness as a regulator is limited.

Dairy Farm Sterilization. At the dairy farm sterilization of utensils is the first operation encountered. Where hot-water sterilization is used an angle-stem thermometer or index thermometer (Fig. 2) applied to the tank will show existing conditions. Thermometers with a range of at least 60 to 220 degrees can be used. With a thermometer to show existing temperature conditions within the sterilizer, it is not as likely that temperatures will prevail which are too low for proper sterilizing, or too high for economic operation. Excess temperature not only results in a waste of fuel, but has a serious effect in shortening the life of equipment. The Bureau of Dairy Industry of the U. S. Department of Agriculture found excellent results could be obtained by sterilizing with water at a temperature of 160 to 170 degrees, without appreciably shortening the life of rubber parts from milking machines. Thus it is folly to guess temperatures when excessive temperature means shortened life of equipment and insufficient temperature means unsatisfactory sterilization.

Dairy Farm Cooling. To cool milk immediately after milking is considered of paramount importance. The cooling may divide into two stages: First precooling to approximately 60 degrees, and then final cooling and storage.

In cooling by means of ice or running water a test thermometer is used advantageously to check the milk temperature. The case of the mechanically-operating refrigerated tank is somewhat different. An industrial thermometer (Fig. 1) with a scale reading 0 to 100 degrees should be used to assure that the desired cooling is obtained. Excessive cooling is detrimental to the milk quality and is inefficient. Insufficient cooling is like-



Temperature observation and control should begin at the dairy farm, both in the cooling of milk and in the sterilization of equipment. Uncontrolled temperatures result in poor bacterial control, wasted power and damaged equipment

wise wasteful, because the maximum return from the equipment investment is not being realized.

Transportation. In transporting milk from the dairy farm, the importance of temperature is so generally accepted that it is not necessary to mention the precaution required to keep the milk cool. An industrial-type cold-milk-testing thermometer (Fig. 6) with a stem of sufficient length to reach the midpoint of a can of milk will indicate whether the necessary low temperatures are being obtained. Thus corrective measures may be applied to eliminate a bad condition, indicated by a test thermometer, before the quality of the milk has become seriously impaired.

Receiving at City Milk Plant. As commonly understood, the temperature of milk when received at the city milk plant is important. During the sampling and weighing operation is the proper time to check the temperature. At this point again a cold-milk testing thermometer of the long-stem type (Fig. 6) is convenient.

Can Washing. After the milk has been poured into the weighing tank, the cans and covers must be washed and sterilized. Rather than mention the numerous types of can-washing machines and the various methods used, it is sufficient to the purpose of this paper to consider only those phases wherein heat is employed; namely, the sterilizing and drying operations. Sterilizing and drying cannot be performed completely unless temperatures are high enough to furnish sufficient heat. These temperatures should be indicated by an index thermometer (Fig. 7). Rapid drying not only leaves the cans in a sanitary condition, but tends to prevent rusting, thus increasing the life of the cans. The importance of sterilizing is sufficient to justify a temperature-indicating device to positively insure sterilization. However, such a device also serves to indicate the minimum operating temperature which will give both economic use of steam and rapid drying. Operating at a temperature higher than necessary for sterilizing and rapid drying is unnecessary and wasteful.

Pasteurization. If any one operation can be said to be more important than another, in an industry where every precaution and method that can be used is used to reduce the bacteria count, then pasteurization is that operation and the major process of the milk industry. Since this operation employs heat, temperature instruments play a major part in all of the pasteurizing methods, that is, batch and continuous pasteurizers, and in-the-bottle and in-the-can pasteurizers.

In discussing the temperature instruments used in conjunction with pasteurization the first two methods only will be considered, namely batch and continuous heating, because they are used by the majority of milk plants.

Both heaters may be divided according to basic differences in construction which necessitate different instrument applications; the four groups are horizontal revolving coil, vertical coil, water jacketed, and hot water spray. Regardless of the type of batch heater, the following types of thermometers are applicable: The industrial mercury-in-glass (Fig. 1), index (Fig. 2), and recording (Fig. 3). The methods for actuating each type is the same.

On horizontal revolving coil and water-jacketed pasteurizers it is good practice to use a long-stem instrument applied vertically through the top. An adjustable flange on the stem permits locating the bulb chamber for complete immersion at the lowest milk level. Or the angle-stem type may be applied through the end, near the bottom of the vat, with its scale in a vertical or reclined easy-reading position, by using the generally accepted International Association of Milk Dealers sanitary connection. This form of connection being free from corners and crevices permits thorough cleaning and easy removal of the thermometer. This type of thermometer and method of attachment is also used for glass-lined vats. When the thermometer bulb extends into the water jacket a conventional union connection is satisfactory.

Spray vat and vertical coil machines employ a long-stem thermometer ranging in length from 18 to 52 inches, depending on the size of the apparatus. Attachment is made with a sanitary fitting or a union connection. For greatest utility and accuracy, mercury-in-glass or industrial thermometers should have a scale at least 7 inches long.

A recorder (Fig. 3) operating in conjunction with a pasteurizer will provide a permanent record, telling whether proper temperatures existed and were held the desired time during pasteurization, whether the cooling operation was prompt and if the desired temperature was reached (when cooling is done in the pasteurizer), whether steam was wasted by sterilizing at a higher temperature or for a longer time than necessary, and finally whether sterilization was satisfactory with respect to temperature and time.

Although continuous heaters divide into two main classes, according to heating methods, namely, internal and barrel, heat is the common pasteurizing agent and tem-

perature instruments, therefore, are necessary. In addition to the industrial (Fig. 1), index (Fig. 2), and recording (Fig. 3) thermometers, regulators (Fig. 4) fulfill a very definite requirement.

Since the use of instruments in the two heating methods are the same, the internal tubular system will be used for illustration purposes. Heating is frequently divided into two stages; therefore, an industrial thermometer should be installed on each heater to assure that the heating load is properly divided and carried by the preheater and final heater. A recording thermometer similar to the type just mentioned with reference to batch pasteurizing should be installed with the bulb as close to the heater as possible. To assure a constant temperature of the milk delivered to the holders by the heater, a temperature regulator is necessary to control the heat supplied in the form of steam.

Like the recording thermometer, the bulb of the regulator is used with either a union-connecting hub or a sanitary ferrule, and is installed in a tee as close to the heater as possible. The elements which must be considered to obtain satisfactory temperature control of the milk as it leaves the pasteurizer outlet are (1) pressure of steam supply, (2) rate of flow of milk, and (3) temperature of incoming milk.

With a varying pressure on the steam supply, the amount of heat delivered to the milk for a given opening of the diaphragm valve is not constant. By installing a pressure regulator in the steam line, ahead of the temperature controlling diaphragm valve, this objectionable condition is eliminated.

A fluctuating rate of milk flow likewise is detrimental to close regulation. The use of proper auxiliary milk-handling equipment is an essential factor to be considered. Also the temperature of incoming milk must be held fairly constant. The design of the equipment and the plant layout has much to do with the closeness of control obtainable.

Holding. When water or steam jackets are used as a means of maintaining a constant temperature of milk in a holder, a temperature regulator (Fig. 4) also plays a part. The same elements, namely, constant steam pressure, constant rate of milk flow, and a constant temperature of incoming milk, are desirable if the temperature of the milk in the holder is to be held throughout the pasteurizing period with the minimum temperature fluctuation.

In the case of water-jacketed holders, an industrial thermometer with a range of 30 to 160 degrees should be used. As an alternative an index thermometer is applicable.

The temperature of the milk leaving the holder for the cooler should be recorded by means of a recording thermometer similar to that described in connection with the heater. If the heater and the holder recorder charts are the same range and graduation, the pasteurizing history is recorded complete. The heater chart will show the temperature of the milk delivered to the holder; the holder chart will show the temperature of the milk at the end of the hold or pasteurizing period.

Cooling. Temperature is a factor to be considered also in milk-cooling apparatus. Not only is it important to have a graphic record of the temperature to which milk was finally cooled, but when a refrigerant such as brine is used, a temperature regulator will assure desired cooling temperatures being obtained with a minimum expenditure of the cooling medium.

If the cooler, for some reason, is operating at a low efficiency, and although the milk should leave the cooler, we may assume, at a temperature of 35 degrees, in reality it is only being cooled to 55 or 60 degrees, immediate steps should be taken to correct the condition and properly cool the milk at the cooler instead of in the cold-storage room. The cooler is more economical as a means of cooling (since it depends on direct contact or conduction) than the cold-storage room, which depends on indirect contact or radiation. Thus a thermometer serves as a check and prevents wasteful expenditure of refrigeration.

Bottle Washing. Temperature plays an important part in bottle washing. Excess temperature at the beginning of the washing operation causes breakage. Insufficient temperature at the end of the operation permits bottles to pass unsterilized. In case of automatic bottle-washing machines employing from three to five tanks, for efficient operation, definite operating temperatures are required in each tank. To indicate temperatures an index thermometer (Fig. 7) should be used. To save steam and the operator's time in adjusting valves, in addition to a uniform operating temperature, a regulator is suitable and desirable.

Cold Storage. Cold storage is a refrigeration problem and is one of heat extraction from the hot compressed gasses, as well as from the air in the cold-storage room.

Although refrigeration is necessary in a milk plant, time does not permit discussing in detail the important part temperature plays. It is advisable to pass refrigeration proper as a subject apart from the milk handling, and simply point out again that operating conditions where heat is involved cannot be known without thermometers. In the absence of accurate temperature knowledge, inefficient operation is not only possible but in most cases is positively assured.

SUMMARY

The three phases of temperature instruments to be considered, in summarizing, are construction, installation and operation.

Construction determines the performance, service and accuracy of instruments. Five major points are important: Sealed adjustment, sturdy and rigid construction, moisture-proof case, durable material and finish of parts, sanitary construction of parts in contact with milk (the elimination of sharp corners and crevices).

Installation determines performance and accuracy of the instruments, and has a very decided influence upon results obtainable from the equipment. Temperature instruments must be considered an integral part of all equipment wherein heat is a factor. The location of the bulb is of vital importance to accurately indicate, record or control temperatures.

Operation depends upon construction and installation. The operating results manifest themselves in reduced costs, uniform quality, and higher standards.

Temperature control is an essential part of present milk-handling methods. Temperature instruments are necessary to meet the requirements of a most exacting industry. They will do their part in making it possible to meet the more stringent requirements of the future.

Second Record Cow Milked by Machine

AN OREGON Jersey cow, The Lion's Lilac, recently established a world's record production of 926.55 pounds of butterfat and 13,844 pounds of milk in 305 days. She was milked by machine throughout the year, according to her owner, Harry D. Iliff, who has the distinction of being the only Jersey breeder in the world to own four living Jersey cows that have each produced over 1000 pounds of butterfat in one year. This distinction is more notable because Mr. Iliff's herd consists of only twelve cows.

This is the second mechanically milked cow in three months to establish a national record. The other record breaker was a four-year-old Holstein cow in Wisconsin, whose owner used a milker throughout the entire test period.

Controls for Alkali Cleaning Solutions[1]

By W. G. Goss[2]

TECHNICAL investigators are in agreement on the main essentials of bottle cleaning, in that bottles exposed to a 3 to 4 per cent caustic solution for 5 minutes and at a temperature around 140 degrees (Fahrenheit) will render the average run of bottles physically clean and sterile. J. H. Buchanan and Max Levine[3] recommend that milk bottles be subjected to a 3 per cent caustic at 130 degrees for 5 minutes, and go on to state that caustic concentration and time exposure are interchangeable factors whereby a 50 per cent increase in caustic content will reduce the washing time 50 per cent between the temperatures of 120 to 160 degrees. C. S. Mudge[4] brings out the fact that time, temperature and concentration as measured by bacteria surviving are the controlling factors. Myers[5] is of the opinion that hydrogen ion concentration is the controlling factor in kiling bacteria and buffer action is also very important, and recommends a solution with a pH 12 or above for effective work.

F. L. Seymour-Jones and A. J. Powers[6] agree closely with others, while the state of Pennsylvania and Chicago require that 3 per cent caustic strength be maintained.

Practical experience and work by G. Bell[7] point to the same end, that is, a 3 to 4 per cent caustic content at a temperature around 150 degrees with an exposure of 5 minutes or over renders bottles clean and sterile.

However, some of these men do not agree on the alkali used in conjunction with sodium hydroxide, for rinsing off the caustic solution after the soaking operation. Sodium carbonate (or soda ash) and tri-sodium phosphate seem to be on even terms. It depends with whom you talk.

Since we have stated the general condition, how are we going to maintain the soaking solution at these various levels of chemical strengths?

Up to a few years ago no serious effort had been made to give the machine operator or the plant control man an understandable means of knowing precisely and with simplicity what his soaking solutions contained, how long they lasted nor how to bolster them up in the compartment or tanks. The bottles either came out clean or they did not, and chances are the "buck" was passed to some other department if the milk was not reaching the housewife in good condition. It doesn't take a great stretch of imagination to see that improperly cleaned bottles caused some of that trouble.

Lately considerable attention has been given to this problem with the result that we are getting somewhere. Various workers have taken the technicians' methods, modified them and have given the bottling plants a means by which washing operations can be controlled.

Four of these tests come to mind. They are:

1. The hydrometer for measuring the specific gravity of the solution
2. The A.B.C.B. tablet test for determining total alkali strength of soaking solutions
3. The Nafis automatic caustic test for determining the caustic and carbonate content of bottle-washing solutions
4. The proposed test by Myers to detect the hydrogen ion concentration of a solution employing tri-nitro-benzine and phenolphthalein indicators with hydrochloric acid.

Before going further, it may be well to say that my discussion of the various tests are made with an idea of comparison and not as destructive criticism. Each test has its weaknesses and its merits, and none of them will meet every condition.

The hydrometer will give correct readings of specific gravity of new solutions at the temperature to which it is standardized, but with used solutions it may be off several degrees because of the increase in specific gravity, due to collection of dirt, grease, emulsified fat, etc.

The A.B.C.B. tablet test, with which most of you are familiar, is conducted by measuring 10 cubic centimeters of the soaking solution into a glass tumbler and dropping in a pill. If the solution remains blue, it contains over 1 per cent total alkali; if it turns yellow, the solution has less than 1 per cent total alkali, and by dropping in and dissolving a successive number of tablets until you obtain the yellow color you arrive at the strength. Each tablet represents 1 per cent total alkali and you can come within ½ per cent by using half a tablet. However, a question arises here that we have not answered with the tablets. The solutions we usually test contain more than one alkali and how are you to know whether you have an excess of carbonate or sodium hydroxide, since these tablets react in pure solutions of either?

Probably the most complete test to date, but by no means the last word, is the standard method worked out for commercial use by Parker[8] known as the Nafis automatic caustic (alkali) test. It employs a standard hydrochloric acid and two indicators, methyl orange and phenolphthalein, a double-scaled burette graduated to read direct in per cent of caustic soda after one simple subtraction and direct in per cent of carbonate. Determination of these constituents of washing powder may be made in solutions when tri-sodium phosphate or other alkalies are present by precipitating them out with barium chloride. You may also determine the sodium hydroxide and sodium carbonate of washing powders with this outfit.

In regard to the proposed test by Myers for the determination of pH concentration with indicators and hydrochloric acid, it has considerable merit and can be used with solutions of many compositions. Other factors besides content must be considered in a soaking solution and the test provides for some of these in the determination of the buffer action. A test should provide (in all fairness to the user) some means of helping him maintain the desired strength of the soaker solutions at a nearly constant level.

The following table is a summary of a record kept for period of 41 weeks in a modern dairy. An automatic caustic test was used in the control of the soaking solutions in a five-compartment soaker-type washer that turns out on the average 42,000 bottles daily. For a period of 41 weeks (operating 7 days a week) it is estimated that 12,000,000 bottles passed through the machine.

	Comp. I	II	III	IV	V
Highest caustic, per cent	5.0	3.9	3.3	3.3	2 6
Lowest caustic, per cent	2.5	2.4	2.1	2.0	0.8
Average caustic, per cent	3.72	2.6	2.56	2.5	1.48
Highest carbonate, per cent	2.5	2.4	2.1	2.4	1.3
Lowest carbonate, per cent	0.9	1.2	2.0	1.0	0.0
Average carbonate, per cent	1.97	1.67	2.5	1.72	0.75

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition, at Toronto, October 1929.

[2]Assistant manager, Louis F. Nafis, Inc.

[3]A.B.C.B. Educational Bulletin No. 1, August 1929.

[4]Cleansing and Sterilizing with Alkaline Detergents, C. S. Mudge, Food Industries, October 1929, page 613.

[5]Journal of Agricultural Research, R. P. Myers, Vol. 38, No. 10, page 521.

[6]A. J. Powers and F. L. Seymour-Jones. Food Industries, October 1929.

[7]G. Bell, Sidney Wanzer & Sons Dairy, Chicago.

[8]Milton E. Parker, "Milk Dealer," November 1926.

A review of the table shows that the first or receiving compartment suffered the largest variation in caustic strength, as it bore the heaviest job of washing. The other three compartments show a decidedly even trend in caustic strengths. These most nearly approach the ideal condition.

The fifth compartment of this machine is of interest as it shows the weekly mechanical carry-over or transfer. This compartment was filled weekly with fresh, clean water before beginning operations. The average weekly loss experienced amounted to 1.48 per cent caustic, representing about 162 pounds of alkali or approximately one-half barrel a week, or approximately 20 barrels in 41 weeks.

For recharging the compartments 300 gallons of strong caustic liquor were prepared in a separate tank, using 600 pounds of 2 to 1 washing powder. Tests were made of the various compartments throughout the week and sufficient concentrated solution was added to bring the soaking mixtures back to the desired standard.

The requirements were figured out from the accompanying tables.

Each week the contents of Compartment No. 1 were dumped and the soaking solution from the section chosen for recharging was pumped to No. 1 and the solution brought up to the desired strength by addition of some of the strong caustic prepared previously in a separate tank. A rotation of compartments was established so that the oldest solution was always to be found in the first compartment.

The rinsing solution in Compartment 5 was pumped to the emptied tank and sufficient strong caustic liquor was added to bring it up to the desired strength. Under this system (1) the oldest solution was destroyed each week, (2) the rinsing solution containing 1.49 per cent caustic soda was utilized, and (3) the solutions in the various compartments were maintained at the desired strengths.

The control man in charge of this machine reports clean, sterile bottles as determined by the plate count and enthusiastically added that they have not experienced trouble from dirty bottles for over two years, surely a strong recommendation for systematic control of soaking solutions and machine operation.

In summary there are several facts that should be briefly restated and some suggestions offered:

1. For satisfactory results milk bottles should be subjected to a cleaning solution of 3 to 4 per cent caustic strength for 5 minutes or over, at a temperature of 150 degrees.

2. Caustic strength and time factors are interchangeable to some extent between the temperatures of 120 to 160 degrees.

3. Find out from your local health department what the requirements are; comply with them for the protection of your customers and yourself.

4. Select the best brand of alkali adaptable to your needs; if it gives satisfaction stick to it.

5. Employ some test for daily determination of strength of soaking solutions; it will save you time, annoyance, money.

6. Establish a definite system of checking, recharging and reenforcing the bottle-washing machine. Above all stick to it after you have once started it, and it will eventually become a habit.

Guide Tables for Use with the Nafis Automatic Caustic (Alkali) Test

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The following tables may be effectively used as guides for making up new alkali solutions or for reinforcing the used solutions in the soaking compartments of automatic bottle washers. Washing powders containing from 60 to 75 per cent caustic soda will be the most efficient and economical.

Table for Use with 76 per cent Caustic Soda

	Pounds caustic to use for free caustic per cent solutions	
Tank Capacity	Each 0.1 per cent	1.0 per cent
10 cu. ft.	0.74	7.4
20 " "	1.48	14.8
30 " "	2.22	22.2
40 " "	2.96	29.6
50 " "	3.70	37.0
60 " "	4.44	44.4
70 " "	5.18	51.8
80 " "	5.92	59.2
90 " "	6.66	66.6
100 " "	7.40	74.0
110 " "	8.14	81.4
120 " "	8.88	88.8
130 " "	9.62	96.2

1. For each cubic foot not shown add 0.74 lb. caustic soda to nearest tank capacity (shown in table) below the tank capacity for which calculation is made in 1% column. For higher concentrations continue as indicated in Paragraph No. 2. Example: How many pounds of caustic soda should be added to a 51 cu. ft. tank to give a 1% free caustic solution? 37+0.74=37.74 lb. caustic soda to be added to a 51 cu. ft. tank for a 1% free caustic solution.
2. For any concentration over 1% multiply the pounds of caustic soda for the tank capacity in the 1% column by the per cent concentration desired. Example: A 3% free caustic solution is wanted in a 50-cu. ft. tank. 37x3=111 lb. caustic soda required for 3% free caustic solution.
3. To reinforce a solution, subtract the free caustic reading shown by the Nafis automatic caustic test from the per cent solution wanted. Multiply the result by the factor opposite the tank capacity in the 1% column. Example: 111 lb. of 76% caustic needed for a 3% free caustic solution in a 50 cu. ft. tank. The burette shows 2.5% free caustic present. How many pounds of caustic required to reinforce the solution? 3.0—2.5=0.5. 0.5x37 =18.5 lb. of 76% caustic required to bring the solution back to 3% free caustic strength.

Table for Use with 2-to-1 Formula Washing Powder

	Pounds washing powder to use for free per cent solutions	
Tank Capacity	Each 0.1 per cent	1.0 per cent
10 cu. ft.	0.93	9.3
20 " "	1.86	18.6
30 " "	2.79	27.9
40 " "	3.72	37.2
50 " "	4.65	46.5
60 " "	5.58	55.8
70 " "	6.50	65.0
80 " "	7.44	74.4
90 " "	8.37	83.7
100 " "	9.30	93.0
110 " "	10.23	102.3
120 " "	11.16	111.6
130 " "	12.09	120.9

1. For each cubic foot not shown add 0.93 lb. powder to nearest tank capacity (shown in table) below the tank capacity for which calculation is made in 1% column. For higher concentrations continue as indicated in Paragraph No. 2. Example: How many pounds of 2-to-1 washing powder should be added to an 81-cu. ft. tank to give a 1% free caustic solution? 74.4+0.93=75.33 lb. washing power to be added to an 81-cu. ft. tank for a 1% free caustic solution.
2. For any concentration over 1% multiply the pounds washing powder for the tank capacity in the 1% column by the per cent concentration desired. Example: A 3% free caustic solution is wanted in an 80-cu. ft. tank. 74.4x3= 223.2 lb. washing powder required for a 3% free caustic solution.
3. To reinforce a solution, subtract the free caustic reading shown by the Nafis automatic caustic test from the per cent solution wanted. Multiply result by factor opposite the tank capacity in the 1% column. Example: 223.2 lb. washing powder needed for a 3% free caustic solution in an 80-cu. ft. tank. The burette reading shows 2.5% free caustic present. How many pounds washing powder required to reinforce the solution? 3.0—2.5=0.5. 0.5x74.4=37.20 lb. of washing powder required to bring the solution back to 3% free caustic strength.

Modern Water Purification Methods for the Dairy[1]

By M. F. Corin[2] and E. S. Hopkins[3]

THE need for clear and clean water—free from contamination, turbidity and iron—in the dairy industry is well known, and many modern plants have installed, where required, clarification and sterilization equipment to insure a clean, clear, colorless and odorless water supply. In many cases, however, old plants are becoming obsolete and it is frequently advantageous to abandon the present old equipment in favor of properly designed modern coagulation and filtration plants, which are easier to operate and deliver water of better quality at lower cost.

To be safe, sterilization of a dairy water supply is necessary when bacterial test has shown it to contain organisms of pathogenic nature. Modern control apparatus is available for this purpose. Also it is possible to obtain solutions for sterilization containing chlorine that are of value for use in keeping utensils and apparatus in good shape and safe.

The safety of the consumer and community demands that the dairyman observe every precaution to give a wholesome edible product. Such is not possible when even a slightly polluted water supply is used.

The economic considerations in improving or replacing filter plants are similar to those involved in replacing any obsolete equipment. While it is well known that clean and clear water is a necessity for cleanliness, the user frequently overlooks the fact that his particular water supply may be very considerably improved by the installation of proper water-softening equipment with consequent improvement in the efficiency of plant operation and quality of product as well.

Water of zero hardness can be used to great advantage for washing purposes. In this process it appears that large quantities of washing compounds can be saved and at the same time very much improved results be obtained.

Salts of calcium (lime) and magnesium constitute the hardness minerals in water. These occur principally in the form of bicarbonates, sulphates and chlorides. They all react with the detergents (washing compounds) used in a dairy and destroy their cleansing quality, forming precipitates of insoluble lime and magnesium salts, making the water turbid and less suitable, and often unfit for cleaning purposes. But that is not all. Hardness mineral in water also forms insoluble and very sticky combinations with fatty acids. This is seen whenever we use soap with water which contains hardness. Soap is a fatty acid combined with an alkali, usually sodium or potassium. Soap is soluble in and gives a clear solution with perfect soft water, but when hardness of lime or magnesium salts are present, the water turns milky because of the formation of the insoluble lime and magnesium soaps or soap curds, as they are often called.

The amount of detergent or scouring powder which is thus wasted depends upon the amount of hardness that is present in the water. For instance, if a water contains ten grains of hardness per gallon, one thousand gallons of such water will destroy as much as fifteen pounds of soap. In other words, after having added fifteen pounds of soap to the water there is no soap present, but instead one would have the equivalent amount of soap curd in the water which in that condition is unfit for cleaning purposes in a dairy.

It is easily understood that more scouring compound is required to a turbid water than a clear water. Thus as the scouring compound precipitates the hardness making the water turbid, this condition calls for additional washing compound and added cost. The waste of scouring compound is therefore considerably greater than the amount directly destroyed by the chemical reactions between the hardness and the chemicals in the compound.

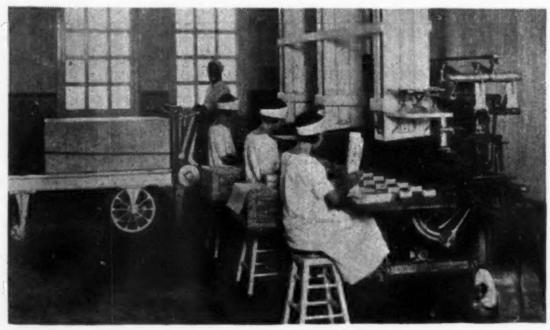
It is readily seen that one can not expect to wash an object cleaner than the water used for the purpose.

No matter how much scouring compound is used, perfect results in washing of milk cans, bottles, churns, pasteurizers, etc., can not be obtained with water containing hardness, because, when rinsing the containers with hard water after they are scoured, the hardness in the water will react with the alkali and the fatty acids and redeposit impurities, as is quite evident.

Therefore, it is most essential that a perfectly softened, zero hardness water should be used to get the desired degree of cleanliness.

The effect of hard water used for scouring milk cans, bottles, and churns, etc., is far reaching because of the nature of the curd which is a combination of lime and a fatty acid. The lime is a strong alkali as compared with the fatty acid as an acid. Thus the curd is alkali in nature and is a most suitable medium for bacterial growth. The decomposition of the curd imparts a rancid flavor and odor. This is one reason why soap is sparingly used in a dairy in spite of the fact that it is the world's foremost means for washing. It is thus evident that the keeping quality of dairy products is greatly dependent upon the character of the water used for scouring. The importance of a perfect soft water for the dairy can not be too much emphasized. It is surprising, to say the least, that even today there are a number of dairymen with otherwise modern plants who hardly realize that they are subjecting themselves to severe losses and the public to untold danger because of their failure to grasp the importance of perfect soft water for the dairy.

Milkstone is a consequence of hardness minerals in the water. It is caused by the precipitates which form when detergents are added to water containing hardness involving also the protein constituents of milk. The coag-



Butter cutting and wrapping equipment. One of the many pieces of machinery in the modern dairy plant which requires clean, soft water for its efficient cleaning and operation

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition, at Toronto, October 1929.

[2]Chemical engineer and district manager, The Permutit Co.

[3]Sanitary chemist, Bureau of Water Supply of Baltimore.

ulum which adheres to the metal surfaces of the pasteurizer absorbs these lime precipitates caused by the reaction between the detergent and the hardness in the water. This process which is cumulative can be entirely eliminated and prevented by the use of zero hardness water as produced by a properly designed zeolite water softener, but is almost impossible to correct by other means.

It is of great importance that all metal surfaces with which dairy products come in contact shall be kept scrupulously clean because of the fact that butterfat readily absorbs flavors and odors from substances with which it comes in contact. It will absorb metallic flavor from metallic salts, which flavors often become more pronounced upon standing, because of reactions which follow and changes which go on in the butterfat.

Improper scouring and rinsing of milk cans, churns, etc., or the use of a water containing oxygen-carrying metals, such as iron and manganese may be the cause of this. These metallic salts take up oxygen from the air forming the oxides which will give up a part of their oxygen to other substances which have affinity for oxygen. Some of these peculiar reactions may be due to a catalytic reaction in that, while the metallic oxides do not take direct part in the reactions which go on, their presence induces the reactions and the oxidations which cause off-flavor.

Soap curd or deposits left to decompose on the surface of a metal will cause a complex of peculiar odors and flavors. Copper is a very active metal in this respect. Many alloys contain copper.

In the art of water purification there has been developed the zeolite process of softening water which produces zero hardness water ideal for dairy purposes. This process is extremely simple to operate. It is automatic and requires no chemical knowledge whatever on the part of the operator.

This process of water softening has the great advantage of transforming the harmful lime and magnesium salts into the beneficial sodium salts. The bicarbonates of lime or magnesium are transformed into sodium bicarbonate which further adds to the cleansing quality of the soft water. The consequence is that a water high in bicarbonate or temporary hardness, after being softened by the zeolite process, will give far better results even without aid of detergents than will the original hard water with use of detergents.

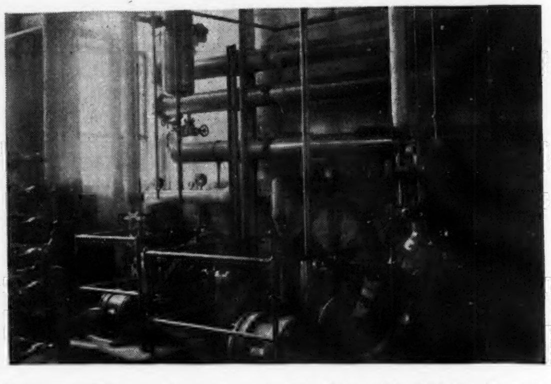
When soap or detergents are added to a zero hardness water they go into a clear solution. Every ounce added to the water remains in solution and is there to do the work as intended.

When rinsing after the scouring, the zero hardness water does perfect work and does not redeposit impurities as is the case when hard water is used.

The limited time does not permit a general discussion of the various phases of water purification. Therefore, we will only make a few remarks with reference to the zeolite system of softening water, which we feel is of particular interest to the dairy industry.

Zeolite plants accomplish the removal of the hardness by simple filtration of the water through a bed of zeolite material suitably supported in a container equipped with strainer system piping and valves to properly distribute and control the flow of water. The hardness is removed from the water by the well-known base exchange principle, the zeolite exchanging its sodium base for the calcium and magnesium bases in the water. A meter is provided to indicate when the softener has passed the quantity of water it was designed to soften.

The zeolite bed is then automatically regenerated or revivified by passing a solution of salt (common brine) through the softener. The brine by a reverse exchange reaction gives its sodium base to the zeolite, and as it leaves the softener it carries with it in a clear solution the calcium and magnesium extracted from the zeolite. The zeolite is then rinsed free of brine and the softener is again thrown into service by opening the necessary valve.



Dairy cooling equipment may be damaged by hard water where this is warmed up enough to precipitate some of its hardness materials

On passing hard water containing either temporary (carbonate) or permanent (sulphate or chloride) hardness through a bed of zeolites, the hardness is removed according to the following reactions in which "Ze" represents zeolites.

$Na_2.Ze+Ca(HCO_3)_2=Ca.\ Ze+2NaHCO_3$ (removal of Ca bicarbonate)

$Na_2.Ze+MgSO_4=Mg.\ Ze+Na_2SO_4$ (removal Mg sulphate)

When the zeolite has exchanged its available sodium for calcium and magnesium, it is regenerated by a reverse of the water-softening process, by passing a common salt solution (brine) through the mineral.

$Ca.\ Ze+2\ NaCl=Na_2\ Ze+CaCl_2$

$Mg.\ Ze+2\ NaCl=Na_2\ Ze+MgCl_2$

The different types of zeolites vary in their softening capacity, the time required to completely exhaust and to completely regenerate them, and the amount of salt to regenerate them. To explain these differences, the zeolites used today may be classified for practical purposes on the basis of their physical structure into the following two groups:

1. Porous zeolites, light-weight mineral
2. Practically non-porus or solid zeolites, heavy weight.

The grains of the first group are, as the name implies, filled with minute microscopic holes or passages of capillary proportions.

To this group belong the so-called "artificial" zeolites whether made by fusing the ingredients together in a typical glass furnace and then hydrating and leaching or whether made by a precipitation process. Whether they contain aluminum or iron as a constituent is of no importance. The so-called "natural" zeolites made from clay that is passed through a series of artificial operations, such as grinding, shaping, baking and hydration, also belong to this porous group.

The grains of the second group are practically non-porous or solid. They are like tiny pebbles, and the contact of the water with this zeolite is practically restricted to their outside surfaces. To this second group belong the zeolites consisting of glauconite.

All zeolites have about the same specific gravity, 2.0 to 2.4, but the zeolites of the first group by reason of their porosity weigh less per cubic foot than the more solid zeolites of the second group. The various porous zeolites when in moist condition weigh from 40 pounds or even less up to 70 pounds per cubic foot, according to their porosity. They contain water up to 50 per cent of the total weight.

The non-porous zeolites in the moist condition weigh about 100 pounds per cubic foot, and about 90 pounds per cubic foot air dry.

The base exchange power between regenerations means

the total number of grains of hardness, usually expressed as calcium carbonate, which a cubic foot of zeolite absorbs or exchanges up to the point when "zero hardness" water is no longer produced. This may be called the "softening capacity" of the zeolite and must not be confused with the "total exchange" power. The function of the zeolite softener is to produce nothing but "zero hardness" water. After this point is passed, the zeolite still has base-exchange power left and considerable additional water can pass through in a partially softened condition before the water emerges with the same hardness with which it entered.

The base-exchange power or water-softening capacity is directly proportionate to the active surface of the zeolite. Since the porous zeolites have an active interior as well as an exterior surface, it would naturally be expected to have greater water-softening capacity than the solid zeolites.

The softening capacity of a practically non-porous zeolite of about ½ millimeter grain size is about 2,500 to 3,000 grains as $CaCo_3$ per cubic foot and with increasing porosity the capacity of the porous zeolite increases to 10,000 grains as $CaCo_3$ per cubic foot and higher. This means from the theoretical point of view that the amount of non-porous solid zeolites must be larger if they are expected to do the same work between regenerations as the porous ones, assuming that the porous mineral retains its exchange power.

The internal surface of the porous grains are harder to reach than the external surfaces of the solid granules. To pass the liquid over the external surfaces takes comparatively little time. This holds true with the water softening reaction as well as the regeneration. Thus the solid zeolites and the outside surfaces of the porous zeolites can be regenerated in 20 to 30 minutes, whereas the interior surfaces of the porous zeolites may require one or more hours.

The porous zeolites are usually larger in grain size than the non-porous zeolites. This gives the latter somewhat more external surface area for the same volume of material. The smaller a sphere is the greater the ratio of its surface area to its volume. But if the porous zeolites are reduced to the same grain size as the solid zeolite and only the external surfaces were called into action, both types of zeolites will act at the same rate and produce that amount of soft water which corresponds to their exterior surfaces. The difficulty in bringing the liquid in contact with interior surfaces causes the delay in utilizing them.

Generally speaking, it is not the stuff of which the solid zeolite is made or the way it is processed which makes it a "rapid-rate" material, it is merely the physical arrangement of the active reacting surfaces on the outside of the grain.

More time and brine are required for regeneration of porous zeolite, because of the difficulty of reaching the inner parts of the grains.

In general the porous zeolites are used advantageously for hard, perfectly clear water, free of iron. Such water is comparatively seldom found. It is essential that the porous zeolites receive clear water, free of iron and organic matter, because the inner passages must be kept clean and accessible. Mud, suspended matter, iron, etc., would clog these passages up and then the porous zeolite would become inactive.

The solid zeolites are adapted to all waters, even those that are not crystal clear, such as filtered river and lake waters. These zeolites can handle slight amounts of turbidity without loss of efficiency if sufficiently backwashed after each softening run and only require clarifying filters to precede them if the hard water is turbid continuously.

The operation of zeolite water softeners marks a radical departure from the precipitation process. The water is distributed uniformly through the zeolite apparatus, and in its passage through the bed of zeolite the hardness is completely removed. No sludge is formed and no problem of sludge disposal exists. No chemicals are added and the mechanical problem of controlling the feed of chemicals is avoided. The zeolite, and insoluble reagent, reacts completely with the hardness salts of calcium and magnesium in the water.

The fact that the zeolite is insoluble makes possible this complete removal of the hardness from the water without the possibility of there being an excess of reagent in the softened water. The volume of the zeolite used is greatly in excess of the theoretical quantity required for the reaction and thus by mass action drives the chemical exchange, i. e., the softening action, to the end point of zero hardness water.

The capacity of a zeolite softener plant varies approximately in inverse proportion with the hardness of the raw water.

DISCUSSION

MR. GODFREY: A common instance in which hard water is destructive is in the cooling apparatus in butter factories where they use coil vats and run cold water through the coil to cool the cream. The water in passing through is heated up to the point where it precipitates a portion of its solids, and in a short time the coil is practically stopped up and a great many times the manufacturers of the machinery are asked to help. The remedy has always been to use some rather violent purge to clean the coil. It is the same as happens in an automobile radiator. Water-softening plants in such districts will, I am sure, give the creameries so much better efficiency in their apparatus and so much longer life that they will be a profitable investment.

One case came to my notice in London, at the World's Dairy Congress. This plant was using two American bottle washing machines of the pressure jet type. After first installing them they found they were no good, as they simply would not do the work. But after considerable trouble and investigation, a water-softening plant was installed, and by using soft water they got excellent results.

QUESTION: Was it due to the coils being clogged up?

MR. GODFREY: In the main it was due to the water being so hard that the alkali solution did not do the work.

MR. JENSEN: I would like to relate two experiences where the life of the equipment suffered very severely from the use of hard water. One is an installation at Newman, Calif. A pasteurizing coil was put in and in less than a year the coil had disintegrated from the inside. It was found that there was quite a large percentage of magnesium chloride in the water, and it was reasoned out that, due to the high temperature to which some of this water had to be subjected, hydrochloric acid was formed which dissolved the copper surface. The man who operated this plant was very much out of sympathy with the manufacturer who sold him the equipment.

Another instance was in a town in Indiana. In this case the water contained enormous quantities of iron. It was so prevalent that wherever an overflow occurred, there was a red coating over the floor. In this case the cooling equipment was at fault. The heating equipment seemed to stand up, but the cooling equipment completely clogged up in less than a year's time with an iron precipitate, and this particular plant had a lot of trouble with the flavor of their butter. They were making metallic flavored butter.

If water softening or the part water plays in successful plant operation had been understood, there would not have been so much trouble in either case.

QUESTION: The speaker in his paper made the statement that milk stone was caused a great deal by hardness of the minerals in the water. Is that to be interpreted as due to the water you wash up with?

SPEAKER: That refers to the water which is used in the washing, due to the curds that are formed with the soap and hard water.

Question: Is it your feeling that that is the only source of milk stone?

SPEAKER: It may not be the only source of milk stone, but it is certainly one of them and probably the greatest source of it.

QUESTION: We are discussing conditions brought about by the hardness of water, but we do not seem to get very far in how to overcome these conditions. Undoubtedly there is no one remedy that will be a cure-all for the varying conditions. It seems as if there should be some way of testing the water and finding out just what chemicals are in it, and then find some way of overcoming them. Or is this water- softening process a cure-all for all conditions?

CHAIRMAN FARRALL: That is a very timely suggestion. Anyone who has worked with water treatment a great deal knows that no one treatment will be a cure-all for all water. I believe in many parts of the country there are experiment stations that will analyze samples of water for anyone in their territory, usually free of charge, or at least at a nominal cost. They will tell exactly what is in the water and oftentimes suggest the proper method of treatment. In this paper the particular method of treatment, the zeolite treatment, of course, deals with certain types of hardness.

SPEAKER: Any reputable water-softening company will be glad to analyze, for any dairy manufacturer, water with which he is experiencing difficulty, and he would recommend such treatment as would be necessary. That does not apply only to water softening, but also to filtration or the presence of iron. Most water-softening companies are in a position to treat water along any desired lines, with the exception, of course, of bacteria treatment.

MR. MOJONNIER: I had occasion last year to go through a pectin factory, which had had a great deal of trouble with their water supply. Their method for softening the water consisted of a wooden tank, possibly with a capacity of 2,000 gallons, with an agitator. In this tank were mixed the chemicals for water softening. A float was provided in the tank so that the water would be drawn into the water pump from this tank above the point where the precipitate formed. At an expense of about $500 they had a water-softening equipment that was doing the same work for which they would have had to pay $7500, and they got a complete analysis of the water from the insurance company, which recommended the chemicals to use.

The Pseudo-Plasticity of Skim Milk[1]

By Allan Leighton[2] and Floyd Ervin Kurtz[2]

IT IS the purpose of this paper to show, in a brief way, the concentration-plasticity relationships of skim milk.

It has been shown by Bateman and Sharp[3] that the rate of flow or skim milk through a capillary tube is not directly proportional to the shearing force, although the departure from proportionality is exceedingly small.

Bingham[4] has shown that in the case of an ideal suspension truly viscous flow is to be had until the concentration of the suspended particles becomes so great that they are packed and the liquid cannot flow through the capillary without the distortion of the particles. He has shown further that in such an ideal case, if fluidity is plotted against volume concentration for dilute solutions, there results a straight line, the extension of which intersects the concentration axis at this "packed" concentration, which is the threshold of plastic flow. No departures from this ideal case are noted in the early editions of Bingham's book.

Bateman and Sharp have recorded data showing the effect of dilution upon the viscosity of skim milk. In order to find at what concentration of milk solids skim milk first becomes plastic, the authors have applied the method of Bingham described above to Bateman and Sharp's data; i.e, assuming for skim milk a close proportionality between volume concentration and weight concentration, they plotted fluidity against weight concentration. As indicated by this method, zero fluidity in these skim milk samples of Bateman and Sharp occurs at a weight concentration of approximately 22 per cent solids. From these data, therefore, one would assume that skim milk of 9 per cent solids concentration should be viscous, or at least not truly plastic.

A search of the literature revealed that Bingham[5] has recognized that some suspensions, particularly paints, are not truly viscous even in a very dilute condition. In such cases the dilute suspensions exhibit but slight friction and are considered by him as pseudo-plastic. Marked friction in such cases is exhibited at a concentration lower than that at which zero fluidity would exist. This, Bingham believes, is caused by the physical nature of the particles, their hydration, etc.

Preliminary work had indicated that skim milk was neither truly viscous nor truly plastic, but rather, if Bingham's terminology is adopted, pseudo-plastic. For the purpose of this paper, therefore, a complete set of measurements was made at 0 degrees (Centigrade) of the plasticity relationships of a fresh skim milk which was concentrated in the vacuum pan to a solids content of 28.46 per cent and then successively diluted, the yield value and consistency being determined for each concentration. The method used in making these measurements has been described fully in a previous paper[6]. The data are given in Table I. The yield values and the reciprocals of the consistencies (mobilities) are plotted against solids concentrations in Fig. 1.

It is apparent that in the lower concentrations of milk solids the mobility-concentration curve becomes the fluidity-concentration curve. As had previously been done with Bateman and Sharp's data, the latter was extended linearly to the concentration axis which, as reference to Fig. 1 will show, it intersected at about 17 per cent; whereas the curve constructed from Bateman and Sharp's data intersected at about 22 per cent. This difference probably can be attributed to the difference in physical condition

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition at Toronto, October 1929.

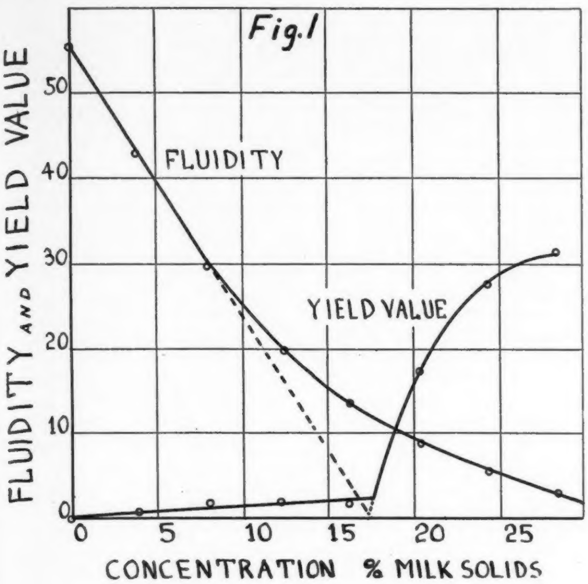
[2]Research laboratories, Bureau of Dairy Industry, U. S. Department of Agriculture.

[3]Bateman, G. M. and Sharp, P. F. Jour. Agri. Research, 36, No. 7,647 (1928).

[4]Bingham, E. C., Fluidity and Plasticity, 1st ed. p. 201.

[5]Bingham, E. C., Bruce, H. D. and Wolbach, M. O., Jr. Ind. Eng. Chem., 14, 1014 (1922), and Bingham, E. C. and Jacques, A. G. Ind. Eng. Chem., 14, 1034 (1923)

[6]Leighton, Allan, and Kurtz, Floyd Ervin. Jour. Phys. Chem. 33, 1485 (1929)



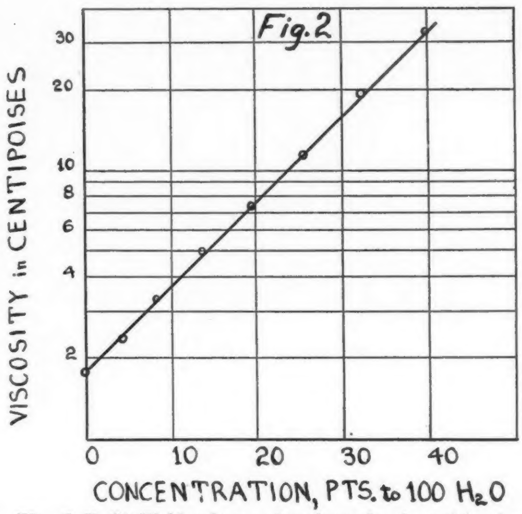


Fig. 1 (Left) Yield values and reciprocals of consistencies (mobilities) plotted against solids concentration. Fig. 2. (Right) Logarithms of consistencies plotted against concentrations

between the skim milk used by Bateman and Sharp and that used in these experiments. Further reference to Fig. 1 shows that at the same concentration of about 17 per cent solids there is a marked increase in yield value. This substantiates the conclusion already drawn from the fluidity-concentration curve that approximately 17 per cent solids for the skim milk used in these experiments is the borderline concentration between viscosity or pseudo-plasticity and true plasticity. A slight friction exists at all the more dilute concentrations, as would have been predicted from the data of Bateman and Sharp. The normal skim milk of 9 per cent solids is seen to be well within the pseudo-plastic zone. According to the data, evaporated skim milk at normal concentration (approximately 3 to 1) is markedly plastic. This also is in accord with the data given by Bateman and Sharp.

In a paper dealing with the basic viscosity of ice cream mixes by Leighton and Williams[7] it was shown that a simple relationship exists between the concentration of the mix and the logarithm of the viscosity, i.e., $\log\Sigma = \Theta C + K$, where Σ is the viscosity in centipoises, C the concentration in parts solid to 100 parts water, and Θ and K are constants. Since the consistency of a plastic material is considered analogous to the viscosity of a viscous substance and since the concentrations of milk used in the above experiments cover a range from practically zero yield value to one of 31 dynes, it seemed of interest to plot the logarithms of the consistencies against the concentrations. Fig. 2 shows the relationship to be linear.

[7]Leighton, A., and William, O. E. Jour. Phys. Chem., 31, 596 (1927).

TABLE I. Plastic Properties of Skim Milks of Varying Concentration

Concentration: Per cent milk solids	Concentration: Pts. per 100 H_2O	Yield value in dynes per degree (Centigrade)	Consistency or viscosity, centipoises	1/C
28.46	39.9	31	33.46	0.0299
24.39	32.2	27	19.13	0.0523
20.33	25.5	17	11.55	0.0866
16.26	19.5	1	7.56	0.1323
12.20	13.9	2	5.08	0.1968
8.13	8.9	2	3.36	0.2977
4.07	4.2	1	2.33	0.4291
			Water=1.79	0.5586

In summary, the authors have here reported the results of an investigation on the plasticity-solids concentrations of an evaporated skim milk whose solids concentration has been varied by dilution from 28.46 per cent to lower than 5 per cent.

1. By adopting a method, previously described by Bingham, of plotting fluidity against solids concentrations, from data recorded by Bateman and Sharp, it was calculated that for their skim milk true plasticity is exhibited at concentrations of 22 per cent and above.
2. By employing the same method and the data recorded in this paper for the skim milk used in these experiments, the threshold of plasticity was located at 17 per cent solids.
3. This latter conclusion is supported by yield value—solids concentration curve constructed from data recorded in this paper. This curve shows also that even well below this concentration of solids a slight friction is shown by the solids when the milk is drawn through a capillary.
4. The general conclusion is drawn that skim milk of normal concentration is pseudo-plastic, if we accept Bingham's terminology.
5. A linear relationship is shown to exist between the solids concentrations of skim milk and the logarithms of the consistencies.

Airplane Proves of Great Value in Work of Making Soil Surveys

AN ENTIRE county was photographed recently from an airplane to get the preliminary data for a base map for a county soil survey, reports Dr. A. G. McCall, chief of soil investigations, Bureau of Chemistry and Soils, U. S. Department of Agriculture. The county is Jennings County, in Indiana, 400 square miles in area. This is the first time an entire county has been photographed from the air for surveying the soil.

The photographing was from a height of 13,000 feet, on a scale of four inches to the mile, and cost less than one cent per acre. These aerial photographs supply practically all the base-map data required for the area surveyed, and the photographs are surprisingly helpful in outlining general soil boundaries and in showing areas of soil erosion, but the chief value of aerial photography appears to be the accuracy and speed with which the preliminary work can be done.

Application of Direct Ammonia Refrigeration[1]

By S. C. Lauer[2]

OUR conclusion based on careful research and observation by our engineers is that brine refrigeration in the dairy and ice cream factory must of necessity give way to the more direct method of refrigeration, for if the latter is properly done, results favor it from every standpoint.

The initial investment is reduced materially. Power is of necessity reduced, because of the omission of one intermediate piece of equipment for heat transfer—the brine cooler. Operating cost is reduced by reason of power saving, and, by the elimination of a brine system, maintenance is reduced by the very nature of the plant, because it cuts out equipment and investment. The modern ice cream factory, for example, has so many places for the application of refrigeration that the initial investment in a direct ammonia plant against the conventional brine plant, when properly designed, can be reduced, or is reduced in the ratio of 50 to 35, or 30 per cent less. This reflects itself in all the fixed charges and in maintenance, because of less actual equipment, to say nothing of power saving and general reduction in operating costs. With the reduction in equipment comes the reduction in building space, which, especially in congested areas, is an important factor. The direct power saving in such an ice cream plant comparison is in the ratio of 22 to 14, or 32 per cent.

With reference to the milk cooling system, Fig. 1 shows a diagrammatic sketch of the conventional brine-cooled milk cooler and appurtenances. Our field observations have shown that an average of about 22½ pounds of ammonia suction pressure is used for cooling brine to a proper temperature for milk processing. The same temperature inside the cooler can be obtained by direct application of ammonia at 35 pounds suction pressure. This represents a saving of practically 0.4 horsepower per ton of refrigeration duty over the cooler, including brine pump power. This is better than a 30 per cent saving in power, and possibly more if the refrigeration losses through the conventional brine system were accurately determined and added to the above saving. In addition to maintaining an ammonia charge, a brine charge must be kept up which every dairy operator knows is an item.

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition, at Toronto, October 1929.

[2]Assistant to the president, York Ice Machine Corp.

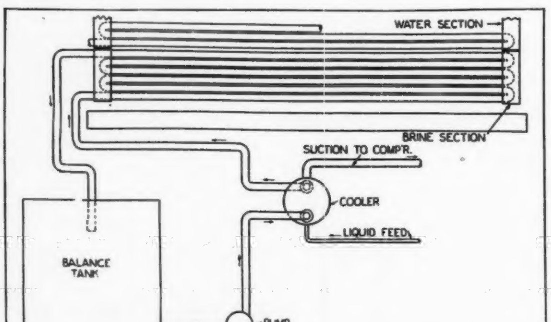


Fig. 1. Diagrammatic sketch of the conventional brine-cooled milk cooler and appurtenances

Then there is the difficulty of short intervals of time between batches, when there is a slight frost accumulation resulting in a weaker product in the first bottles.

Another difficulty in many installations is the inability to drain the milk cooler of brine after the cooling period. It means that the brine temperature must be brought up to the sterilizing temperature, which is a slow process and not a wholesome one for the system.

Another point which is of first importance is the fact that the same compressor capacity functioning on a milk cooler, through direct ammonia application, will do 37 per cent more work than if the refrigeration must be transmitted first through brine.

Fig. 2 shows the conventional so-called direct-expansion, ammonia-cooled milk cooler. There have been may variations to this cooler, since it was first put on the market, and this diagram is intended simply for the purpose of illustrating the ammonia side of it. This shows the usual needle-point hand-expansion valve for feeding the ammonia to the cooler at the bottom. This valve has been replaced in many instances by an automatic expansion valve, so-called, and the suction outlet from the cooler has been provided with a thermostatic chamber which functions directly upon this automatic expansion valve, the purpose being to control the rate of feed of ammonia to the cooler, paralleling the rate of work in the form of milk cooling over or through the cooler.

To take care of variations, suction traps have been installed on the cooler with drain-back connections to the liquid side of the cooler. The supposition is that these traps would gather up sudden liquid return from the cooler and save the compressor from such a shock.

At the outset in our research department we tried these schemes—everyone of them that we could pick up on the market. Our intent was not to show their weaknesses, but to find the best means of putting ammonia through a milk cooler under the varying loads that are encountered, and at the same time make the cooler most efficient and least troublesome in operation.

When one considers the boiling temperature of ammonia at various pressures, it is not difficult to understand why a milk cooler is not a simple device to cool with ammonia. At 35 pound suction pressure the boiling temperature is about 21 degrees, and an increasing amount of milk over a cooler coming on at, say, 90 degrees boils off correspondingly increasing amounts of ammonia.

If a milk cooler were charged with ammonia to some level up in the trap, shown on Fig. 2, which is frequently the case, it is impossible, with any thermostatically operated regulating valve, to control the rate of boiling off with sudden changing loads, for it is apparent that the system is filled with ammonia due to the static head carried in such a trap, and any increased load over the cooler,

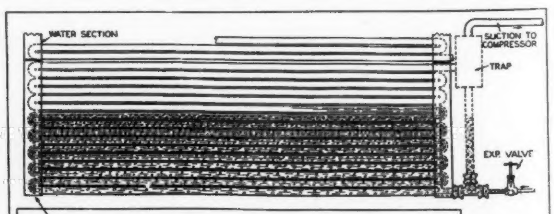


Fig. 2. The conventional direct-expansion, ammonia-cooled milk cooler

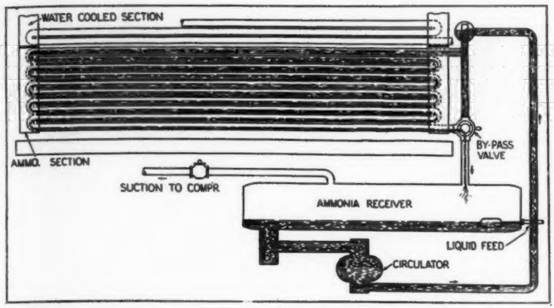


Fig. 3. A patented ammonia liquid recirculating system adaptable to milk coolers of the surface or closed type

in the form of warm milk, increases the boiling and volume of ammonia gas in the cooler correspondingly, and forces out of the cooler, by displacement, an equivalent volume of liquid. Our experiments showed that this condition is almost as sudden and severe as dynamite. The cooler will cough over liquid in spite of the most intricate and delicate devices that can be installed. Consequently, with the arrangement as shown in Fig. 2, it is only possible and practical to charge the cooler at all times to a lower liquid level about as indicated in the tubes. The upper tubes of the cooler are virtually dry pipes, involving enough storage space to take care of these fluctuations in load and not make the liquid flood-back conditions too severe. This means that about six extra pipes must be provided with this type of ammonia application to take care of load fluctuations.

We checked these research conditions in the field with our engineers and found that exactly what occurred in the research plant was occurring in the field. There was no positive control of liquid, and ammonia compressors were suffering as a consequence. When an ammonia compressor handles supersaturated gas, the capacity is materially reduced and the horsepower requirements are materially increased beyond that required for the suction pressure at which they are operated. It represents a dead loss under those conditions. The wear and tear on a compressor under such conditions is enormous.

After making these investigations thoroughly and repeating our tests many times, to be sure of our ground, we evolved a system which we consider to be as nearly foolproof as possible, which would make the operation practically automatic, provide for interruptions of load (which are necessary in the milk cooling business) and require the least amount of milk cooling surface for a given load condition.

Fig. 3 shows, in diagrammatic form, an ammonia liquid recirculation system (patented) adaptable to milk coolers of the surface or closed type, which, according to our research plant results and a great many actual installations in the field, appears to be best for the purpose. This cooler requires 35 per cent less tube surface than the conventional direct-expansion cooler shown in Fig. 2.

Briefly, the ammonia liquid at evaporating temperatures corresponding to about 35 pounds suction pressure is pumped to the top of the cooler from a receiver at a point below the cooler as indicated. The ammonia circulates downward by gravity and from the bottom pipe empties into the ammonia receiver without restriction. Thus it can be seen that every pipe is wetted to a pronounced degree, and while the gas as formed displaces some of the liquid in the lower pipes, there remains a quantity of liquid necessary to completely wet the inside surface of the pipes, because the pump is designed and supplied to handle many times the volume of liquid which is evaporated in the cooler, due to the work done. Thus there is insured liquid in every pipe under all conditions. The ammonia liquid from the plant is fed to the ammonia receiver through a float, sending the "flash gas"

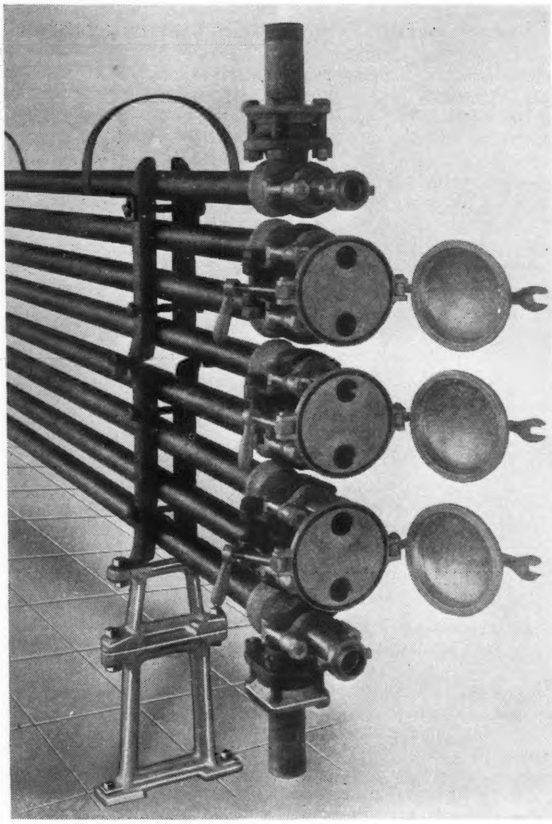


Fig. 4. Construction of an internal-tube, closed type milk cooler

directly to the compressor. In the conventional direct-expansion milk cooler this gas must pass through the cooler and destroys at least 10 per cent of its effectiveness. The liquid is kept at a level sufficiently low so that the remaining volume of space in the receiver will hold the entire charge of liquid in the milk cooling tubes and have some remaining gas space to protect the compressor. It must be apparent to all those who have handled ammonia systems, that this makes as safe a scheme as possible for fluctuating loads such as encountered in milk cooling.

Fluctuating loads on the cooler are handled by corresponding rates of liquid fed through the float valve, maintaining always the same level in the receiver when the pump is circulating ammonia through the cooler. During short intervals, when milk is not passing over the cooler, the operator can switch the hand bypass valve, which allows the cooler to drain into the receiver, and with the pump operating the liquid simply recirculates through the bypass valve and no ammonia is contained within the cooler. Thus there is no frost formation on the coil which would tend to weaken the first run of the next batch cooled. This is a point of importance.

By this same method, the cooler can be emptied of refrigerant immediately after the milk-cooling period, whether it be an open cooler or a closed cooler. This permits steam or hot water to be used immediately, without any possibility of damage, and it saves time and gives the crew a chance to clean up the plant with the least possible delay. We have been told by many dairy operators that this is a highly important feature, and a necessary one in connection with ammonia refrigeration.

To guard against freezing conditions on the cooler, due to fluctuating loads which would result in fluctuating

ammonia suction pressures, we developed, after extensive testing, a regulating valve, which is shown in Fig. 3 on the suction line to the compressor. This maintains a constant back pressure of about 35 pounds on the ammonia system in the cooler, and allows any variation in the suction line to the compressor between the regulating valve and the compressor.

Figs. 4 and 5 show an internal-tube, closed type milk cooler which we developed to meet an apparently increasing demand for that type of cooler, and for ammonia application. With liquid circulation as described and illustrated in Fig. 3 applied to this internal tube cooler in the annular space between the milk tube and the outer pipe, the results are highly satisfactory. The heat transfer rate between ammonia and milk is better than in any other type. These results seem to be evidenced by repeat orders from some large dairies.

Fig. 4 is shown to illustrate the pains taken to make this cooler a solid substantial job, and at the same time a repairable one. The milk tubes, which are of seamless pure nickel, are expanded into recessed heads, eliminating the undesirable idea of welding, in which case the head is lost when the tube is lost. With the expanded tube, it is simple to remove and replace a tube without destroying any other part of the cooler. The cooler can be taken down in sections, as indicated, because the usual double-pipe type of heavy semi-steel ammonia fitting is used to make up the ammonia joints.

In concluding, I wish to say that direct application of ammonia, wherever possible in a process, is the "order of the day" but it is not simply a case of resorting to old conventional methods of expanding ammonia through a closed vessel over which certain fluctuating work is done. The characteristics of ammonia, or other refrigerants, will not permit careless handling without resultant damage. The problem must be approached along careful, scientific lines. The research must be done at the right place, because the public cannot be fooled, and if direct ammonia refrigeration is done carefully, the time will not be far hence when it will be accepted whole-heartedly for all purposes.

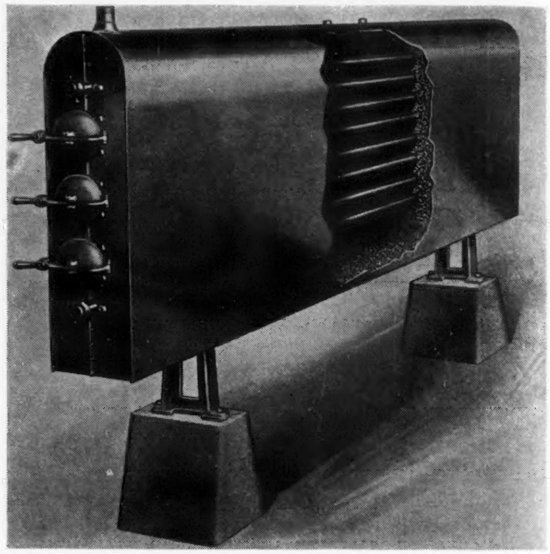


Fig. 5. Same cooler as Fig. 4, with insulating jacket on

Discussion

MR. DERWAY: Is it necessary to have a receiver on each individual cooler?

MR. LAUER: We can have any number of coolers in battery with only one receiver. We take care of that with a distributing header on the discharge side of the pump above the cooler.

MR. WILDEN: Is the by-pass valve hand operated?

MR. LAUER: Yes, at least so far we have done that, so that between batches a man simply snaps it down and the ammonia goes back into the receiver. When you are through cooling milk you shove the whole works down.

MR. WILDEN: Could you operate this valve from a floor above the coolers?

MR. LAUER: You could put an extension on the valve handle. You could also put the distributing header up high on the second floor, and then have the by-pass valve on that floor.

MR. BAILEY: In your diagram I did not see any expansion valve?

MR. LAUER: The float valve is the expansion valve. It simply allows a little liquid to flow into the receiver. The pressure is kept on at 35 pounds.

MR. BAILEY: What cools the liquid ammonia down then? Does the liquid ammonia come first from the condenser?

MR. LAUER: It comes from the condenser and high-pressure receiver, and as the level drops in the low pressure receiver below the milk cooler, the float valve opens and lets more ammonia in.

MR. GALLENKAMP: I think it would be well if you would explain that the liquid feed has no connection to the pump.

MR. LAUER: The liquid feed has nothing to do with the pump discharge. The liquid feed comes from another source into this receiver.

QUESTION: Is that by-pass a three-way valve?

MR. LAUER: Yes.

MR. CORDES: If you stop the pump, do you do the same thing as closing the valve?

MR. LAUER: Yes. If you had a push button switch somewhere to stop the pump, you would do the same thing. The by-pass primarily was put on to take care of reduced loads, so that we would make the cooler a less wetted cooler. Then we simply apply it for the purpose of emptying the cooler between batches.

QUESTION: Don't you have gas building up in the distributing header?

MR. LAUER: No. We use that same system on large coil systems in ice cream plants and we experience no gas building at all. The advantage of that system is that in any case the liquid vessel is below the coil surface and allows complete draining of the refrigerant for the purpose of cleaning, defrosting or the like.

QUESTION: Do you put gages on that system?

MR. LAUER: Yes, it is equipped complete.

CHAIRMAN FARRALL: In the first part of your paper you went into the relative cost of the brine and direct-expansion systems.

MR. LAUER: Of course, that was in an ice-cream factory; it was not in a milk plant alone. If brine is used for the ice cream freezer at a cost of $50,000, the equipment for the same number of gallons of ice cream per day by direct ammonia could be furnished for $35,000, or a saving of 30 per cent on ammonia against brine. The brine system used is brine for all equipment, except the hardening room coils, which in the case of both plants used ammonia.

CHAIRMAN FARRALL: What I meant by that was the operating cost.

MR. LAUER: Thirty per cent is the saving in power without considering the losses to the atmosphere through brine tanks for coolers. The actual saving in power is 30 per cent. Now that also means with the same compressor you may have today working through brine will cool 37 per cent more milk by ammonia application to cooling.

Heat Transfer in Dairy Machinery[1]

By John T. Bowen[2]

THE successful handling and treating of milk and its products depends largely on the control of "heat" and "cold"; consequently a large part of the equipment used has for its object the transfer of heat from one substance to another.

The laws governing the flow of heat from one substance to another are complex, and it is impracticable to employ theoretical formulae for everyday use in the plant; hence, it is necessary to depend largely upon empirical formulae which give results sufficiently accurate for practical work. In practice, temperatures are measured in the body of the liquid, or at the entrance to or exit from the apparatus, and hence differ to some extent from those in the liquid in direct contact with the heating surfaces; also, the temperature of the heating medium diminishes as it moves toward the end of the heating surface. The velocities of the fluids over the heating surfaces, the material composing the surfaces, the condition of the surfaces, and the nature of the fluids being circulated, all affect the transfer of heat.

It is generally assumed in practice that the transmission of heat through metal separating the hot from the cold substance is proportional to the difference in temperature between the bodies of the liquids. Since it is only practicable to measure temperatures at the inlet and outlet of the apparatus, or in the body of the liquid, the mean temperature difference between the hot and cold substances is taken in calculations involving heat transfer.

All substances in nature contain more or less heat, and no way has yet been found for abstracting all of it. In practice, however, we are not concerned with the total quantity of heat a body contains, but only with the changes that occur in the quantity; that is, the quantity added or subtracted in raising or lowering the temperature of a body through a given range.

Quantity of Heat. The quantity of heat absorbed or given up by any substance is found by multiplying the weight of the substance in pounds by its specific heat, and then multiplying the product by the number of degrees change in the temperature of the substance.

$$Q = W x S_h \ (t - t_1)$$

where Q=quantity of heat absorbed in B.t.u.
W=weight of substance in pounds
S_h=specific heat of substance
t=initial temperature
t_1=final temperature.

In order to arrive at the capacity of the apparatus, or to compare its operation with others, the time required to heat the milk must be taken into consideration. In this class of apparatus the hour is usually taken as the unit of time and the formula becomes:

$$Q_1 = \frac{W x S_h \ (t - t_1)}{H}$$

where Q_1=quantity of heat absorbed per hour
H=number of hours operated.

Where one substance gives up heat to another, neglecting radiation, the quantity of heat gained by the one is exactly equal to that lost by the other, that is,

$$W_c x S_c x R_c = W_h x S_h x R_h$$

where W_c=weight of cold substance
S_c=specific heat of cold substance
R_c=temperature range of cold substance
W_h=weight of hot substance
S_h=specific heat of hot substance
R_h=temperature range of hot substance.

Coefficient of Heat Transfer. By the coefficient of heat transfer is meant the quantity of heat in B.t.u. that will pass through one square foot of the separating material per hour from the heating medium on one side to the liquid being heated on the other side, for each degree difference in temperature between the two. The quantity of heat that will pass through a surface of this character, however, depends in general upon the kind of material separating the fluids, the relative velocity of the fluids, the pressure exerted by the fluids against the heating surface, the condition of the surface, whether smooth, covered with scale or grease, etc., and the mean temperature difference between the two fluids. The coefficient of heat transfer is usually designated by the letter "U" and must be determined experimentally for each class of apparatus, and may be found as follows:

$$U = \frac{Q}{A x T_m}$$

where Q=total quantity of heat in B.t.u. passing through the heating surface per hour
A=area of heating surface in square feet
T_m=mean temperature difference between the heating medium and the liquid being heated.

The total quantity of heat, Q, can be determined as previously described; the area, A, can be measured and the mean temperature difference, T_m, will be considered later.

The coefficient of heat transfer varies widely in different types of heaters and to a considerable extent in heaters of the same type. The following values of U, however, may be considered as average for different types of heaters and coolers employed in the dairy industry:

Gravity pasteurizer	U=150	B.t.u.
Counter current heaters and coolers	U=200	"
Surface cooler	U=300	"
Jacketed kettle without stirrer	U=200	"
Jacketed kettle with stirrer	U=300	"
Jacketed kettle, evaporating	U=500	"
Coil vat, heating and cooling	U=200	"
Disk milk heater	U=200	"
Vacuum pans, evaporating	U=500	"
Flash pasteurizer	U=600	"
Atmospheric concentrator	U=1500	"

Most of the heat transfer equipment employed in the dairy industry has the heating, or cooling, medium on one side of a plate, or tube, and the substance being heated on the other side. Since the heat passes through the metal separating the two, the conditions existing at the surfaces of the metal have a marked effect on the rate at which the heat passes through. There is a tendency for a stagnant film of the fluid to adhere to the surface of the metal thus greatly decreasing the rate of transmission to and from the metal surfaces. This film acts as a heat insulator and thus prevents the hotter particles of one fluid and the colder particles of the other from coming in direct contact with the surface of the metal. It is obvious that the remedy for such condition lies in the violent agitation of the fluids, thereby destroying or reducing the thickness of the film and bringing the bodies of the two fluids in more intimate contact with the metal. The more rapid the movement of the fluids over the heat-transmitting surface, the greater will be the rate of transfer per unit of surface. This is due not only to the destroyed, or reduced, thickness of the stagnant film but also to the bringing of the hot and cold portions of the fluids in contact with the metal at a more rapid rate. While the rate of heat transfer increases with the velocity of the fluids over the transmitting surface, a point is soon reached where further increase in the velocity does not pay as the extra power required to produce increased velocity more

[1]Paper presented on the "Dairy Engineers' Day" program sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers, held in connection with the National Dairy Industries Exposition, at Toronto, October, 1929.

[2]Senior electrical engineer, Bureau of Dairy Industry, U. S. Department of Agriculture.

than balances the gain in heat transfer. The type of heater determines, to a great extent, the velocity of the liquids for the most economical operation.

Mean Temperature Difference. The passage of heat through a metal plate or tube from a hot to a cold substance is considered to be in proportion to the difference in temperatures between the two substances. Since the temperature difference varies from point to point along the surface of the metal separating the hot and cold substances, and since it is only practicable to measure the temperatures at the inlet and outlet of the machines, it is necessary to take the mean difference in temperature over the whole surface.

If the temperature difference between the hot and cold substances is determined at the inlets of the machine and also at the outlets, then the true or hyperbolic mean temperature difference between the two is

$$T_m = \frac{\text{Greater temp. diff.} - \text{Lesser temp. diff.}}{\log_e \dfrac{(\text{Greater temp. diff.})}{(\text{Lesser temp. diff.})}}$$

The arithmetical mean temperature difference is sometimes used in calculations of this kind, but the results are often far from correct. The arithmetical mean temperature difference is the sum of the initial and final temperature differences divided by 2. That is

$$t_m = \frac{\text{Initial temp. diff.} + \text{final temp. diff.}}{2}$$

where t_m=the arithmetical mean temperature difference.

The arithmetical mean temperature difference has the advantage of simplicity and in some instances the results obtained by its use are sufficiently accurate for practical work. Care and good judgment, however, are required in its use.

There are in all five different cases of heat transmission through plates and each case is covered by the fundamental equations:

$$W_c x S_c x R_c = W_h x S_h x R_h$$

$$A = \frac{Q}{U\left[\dfrac{t_g - t_l}{\log_e \dfrac{t_g}{t_l}}\right]}$$

The action in each case is illustrated in general by Figs. 1 to 5, inclusive. The formula for the hyperbolic mean temperature difference, T_m, is simplified to

$$T_m = \frac{t_g - t_l}{\log_e \dfrac{t_g}{t_l}}$$

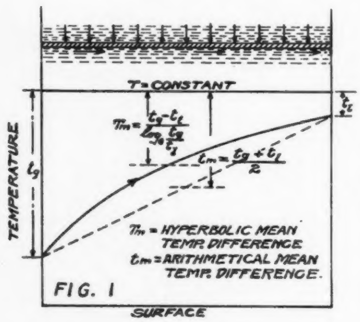
where t_g=greater temperature difference
t_l=lesser temperature difference.

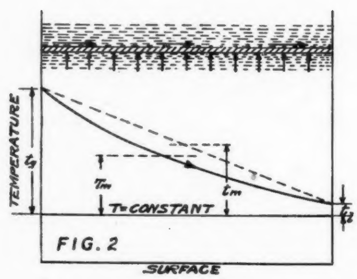
Generally the greater temperature difference between the liquids occurs at the entrance to the heater, or cooler, but it may occur at the outlets in the counter current type of apparatus.

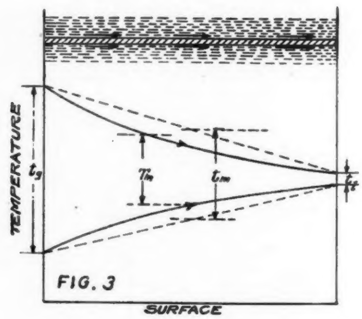
The arithmetical mean temperature difference is given on each diagram and an idea of the magnitude of error resulting from taking the arithmetical mean temperature difference instead of the hyperbolic may be gained by studying these diagrams.

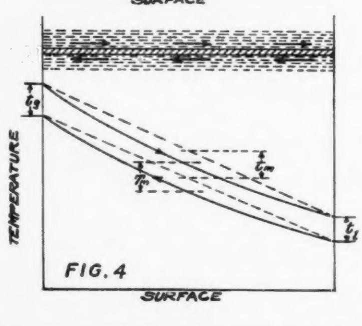
Fig. 1 illustrates a case in which a hot substance at constant temperature gives up heat to a cold fluid which flows. This represents the action of a flash pasteurizer in which a constant temperature is maintained in the jacket by discharging steam into the water contained in the jacket, and the cold milk is caused to flow over the heated surface where its temperature is raised.

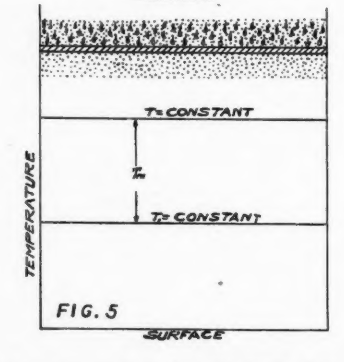
The straight line at the top represents the constant temperature of the heating medium and the lower curve that of the cold liquid which is being heated. The flow is towards the right as shown by the arrow in the curve. The final temperature of the cold liquid depends upon the length of the heating surface. As the cold liquid passes over the heating surface its temperature rises and gradually approaches that of the heating medium, but the











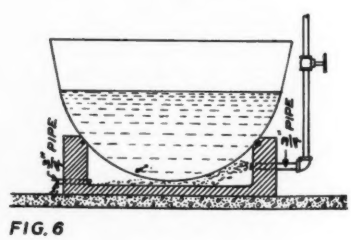


Fig. 1. Hot substance at constant temperature gives up heat to cold fluid which flows. Fig. 2. Cold substance at constant temperature receives heat from a flowing fluid which is lowered in temperature. Fig. 3. Parallel flow heat exchange. Fig. 4. Counter flow heat exchange. Fig. 5. Hot substance gives up heat at constant temperature to a colder substance of constant temperature. Fig. 6. A swiss cheese kettle

temperature difference between the hot and cold liquids diminishes, and hence the rate of heat transmission per square foot of heating surface becomes less.

The condition illustrated in Fig. 2 is typical of some forms of coolers. It is simply the reverse of the preceding case; that is, a cold substance at constant temperature receives heat from a flowing fluid whose temperature is lowered.

The case of parallel flow is illustrated in Fig. 3. The hot and cold liquids which are separated by a plate, flow in the same direction, their temperatures approaching each other as the flow progresses. Since the mean temperature difference decreases rapidly as the flow progresses, it follows that a large volume of heating medium must be used if the final temperature difference is to be small. In general this arrangement should be avoided. If, however, it is intended to use only a relatively small part of the temperature head, this arrangement can be used to advantage since it requires less heating surface to produce the results secured by some other arrangement.

The action of the counter flow currents is illustrated in Fig. 4. In this case the hot and cold substances, which are separated by a plate, flow in opposite directions. The temperature of the hot substance approaches the lowest temperature of the cold substance, and the temperature of the cold substance approaches the highest temperature of the hot as the flow progresses. It will be noted that the heating medium may flow away at a temperature only slightly higher than the initial temperature of the cold substance. Likewise, the final temperature of the cold substance may leave the apparatus at a temperature slightly below the initial temperature of the heating medium. It is obvious, therefore, that the counter-current apparatus economizes in heating, or cooling, mediums. But the mean temperature difference between the heating and cooling liquids is less than in the other arrangements; consequently a larger surface is necessary. For ordinary calculations the arithmetical mean temperature difference between the two liquids can be taken in this type of apparatus as it does not vary greatly from the true mean temperature difference.

The fifth case of heat transmission is illusrated in Fig. 5 and consists of evaporating a liquid in an open-jacketed kettle or in a vacuum pan. In this case a hot substance gives up heat at constant temperature to a colder substance whose temperature is also constant; that is, the latent heat of steam in the jacket and coils of a vacuum pan which is kept at a constant temperature gives up heat to the evaporating liquid inside the pan which is also at a constant temperature. Since the two temperatures are constant, they are represented by straight lines in the diagram and the mean temperature difference between the two liquids is simply the difference between their temperatures.

CLASSIFICATION OF COMMERCIAL HEATERS AND COOLERS

Commercial heaters and coolers may be classified according to the direction of the flow of the milk relative to that of the heating or cooling medium, as: Non-flow, single flow, parallel flow, counter flow.

Non-flow. The non-flow type is illustrated by the open-jacketed kettle which is often used in warming milk before subjecting it to the final treatment, and in the reduction of the volume by evaporation as is done in the manufacture of some types of cheese. In this type of heater both the heating medium and the liquid being heated are stationary except for the natural circulation brought about by unequal temperatures in the liquid. The heating of a mass of liquid in a jacketed kettle is accomplished by both conduction and convection, but principally by the latter.

The rapidity with which heat is transferred through a liquid by convection depends in general upon the specific heat of the liquid, its viscosity, and upon the difference in temperature between the hot and cold portions. Referring to Fig. 6, no provision is made in this type of apparatus for systematic circulation of the contents as is done in most other types. Nevertheless, the heat transfer in the jacketed kettle is high, considerably higher than would be expected from casual observation of a kettle in operation.

When steam is first admitted into a large heating space, as in the case of a jacketed kettle, it immediately spreads out and is condensed, resulting in only a small portion of the heating surface being utilized. As the liquid being heated rises in temperature the effective heating area is increased until the whole area may be brought into service, provided the steam supply is sufficient. The tendency of the steam, however, is to pass from the entrance directly to the outlet, consequently the surface not in the direct path is not so effective. In order, therefore, to maintain approximately equal temperature in all parts of the jacket the steam should be admitted at several points, or a single pipe should pass into and around the jacketed space with suitable openings so spaced as to discharge steam over the entire heating surface. Not only should the steam be discharged equally over the heating surface, but means should be provided for thorough drainage of the condensate from the jacket.

The more rapid the movement of steam over the heating surface the greater the transfer of heat from the steam to the liquid. In case of stagnant steam, as in a jacketed kettle having no steam outlet, the transfer of heat is very slow. On the other hand, if the steam outlet is too large the steam will take a direct path from the inlet to the outlet and large quantities will be wasted. The steam outlet should be provided, therefore, with a trap or a valve which may be adjusted to allow only a small quantity of steam to escape, thus permitting a moderate movement of steam over the heating surface and maintaining a supply of steam in the jacket.

In a jacketed Swiss cheese kettle having two steam inlets entering the jacket at opposite sides, it is desired to heat 1,500 pounds of milk from 60 to 90 degrees (Fahrenheit) in 10 minutes by means of steam at atmospheric pressure. What must the area of heating surface be, if the efficiency of the kettle is 90 per cent?

The mean temperature difference between the steam and milk is

$$T_m = \frac{(212-60)-(212-90)}{\log_e \frac{212-60}{212-90}} = \frac{30}{\log_e 1.25} = \frac{30}{0.223} = 134.5 \text{ degrees}$$

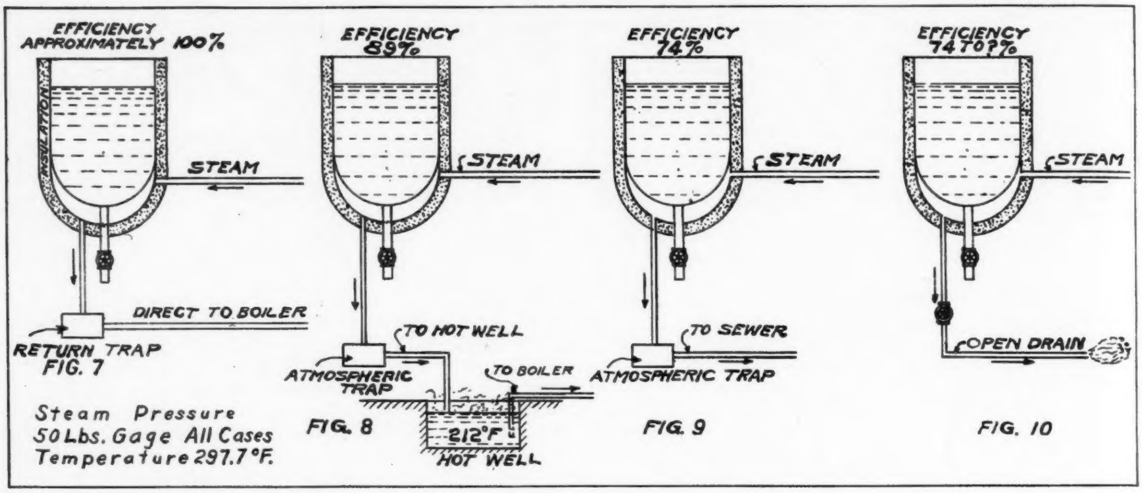
$$A = \frac{W_c \times S_c\,(t-t_1)}{U \times T_m \times h \times E} = \frac{1500 \times 0.93\,(90-60)}{200 \times 134.5 \times 0.166 \times 0.90} = 10.4 \text{ sq. ft.}$$

where A=area of heating surface in square feet
W_c=weight of the cold milk in pounds
S_c=specific heat of milk
t=final temperature of milk
t_1=initial temperature
U=coefficient of heat transfer
h=time in hours required to heat milk
E=thermal efficiency of kettle
T_m=mean temperature difference.

Had the kettle been provided with an efficiency stirring device, the area of heating surface would have been reduced to

$$A = \frac{1500 \times 0.93\,(90-60)}{300 \times 134.5 \times 0.166 \times 0.90} = 6.9 \text{ sq. ft.}$$

It is assumed that the quantity of steam delivered into the jacket is sufficient to make all parts of the heating surface effective. After evaporation commences the temperature in the jacket is approximately constant and that of the evaporating liquid also remains constant, consequently the mean temperature difference is simply the difference between the two. In order to evaporate milk,



Figs. 7, 8, 9 and 10. Connections to open jacketed kettles

steam must be maintained in the jacket under pressure so as to maintain a difference in temperature sufficient to cause the necessary flow of heat from the hotter to the colder substance. The greater the mean temperature difference between the two, the more rapid the evaporation.

Assuming a steam pressure in the jacket of 50 pounds gage and a corresponding temperature of 297.7 degrees and that 500 pounds of water per hour is to be evaporated from the milk, then since the boiling point of milk is about 213 degrees the mean difference in temperature between the steam and milk is 297.7—213=84.7 degrees. The latent heat of evaporation of water at atmospheric pressure is 970.4 B.t.u. per pound. The area of heating surface required under the conditions to evaporate 500 pounds of water per hour is

$$A=\frac{970.4 \times 500}{500 \times 84.7 \times 1}=11.4 \text{ sq. ft.}$$

Efficiency of Jacketed Kettles. The overall efficiency of jacketed kettles varies widely in different installations, depending upon the construction of the kettle and upon the method of installing and operating. Under approximately ideal conditions its efficiency may be almost perfect, the only loss being that due to radiation. In practice, however, but little attention is given to their efficient operation. In but few instances are the kettles insulated, nor are means provided for returning the hot condensate to the boiler. With well-insulated kettles and means for returning the hot water of condensation to the boilers, nearly all the heat given up by the steam is used to heat or evaporate the liquid. In a case of this kind the equipment may be made to approximate 100 per cent efficiency. A model installation is shown diagrammatically in Fig. 7 in which the kettle is jacketed and the hot water resulting from the condensed steam is returned to the boiler by means of a return trap.

In the following cases it is assumed that a steam pressure of 50 pounds gage is maintained in the jacket, having a corresponding temperature of 297.7 degrees, and that there is a 3 per cent loss through radiation from the kettle.

Fig. 8 illustrates a case where the water of condensation is trapped to a hot well and from there pumped into the boiler. Since the temperature of the condensate is reduced from 297.7 to 212 degrees, or 85.7 degrees

$$E=\frac{(1178.4 \times 0.97)-(297.7-212)}{1178.4}=89.8 \text{ per cent}$$

Fig. 9 shows an installation similar to the previous one, except that the condensate is discharged to the sewer and hence is a total loss. The efficiency is

$$E=\frac{(1178.4 \times 0.97)-(297.7-32)}{1178.4}=74.4 \text{ per cent}$$

The arrangement most commonly used is illustrated in Fig. 10, and in some cases is not even provided with a hand valve. The condensate and steam is allowed to pass cut on to the floor of the room or to the sewer. With a hand valve located in the discharge pipe it is possible to regulate the discharge so that water only will pass out in which case the efficiency is under the assumed conditions approximately 74 per cent as in the previous case. When both water and steam are allowed to discharge freely through an open drain the efficiency may be anything below 74 per cent. In addition to the direct increase in efficiency secured by returning the water of condensation to the boiler to be used over again, other advantages are gained,namely, reduction of scale in the boiler, economy in the use of water, and elimination of water on the floor of building, in case it is discharged directly on the floor, as is done in some cases.

Test of Swiss Cheese Kettle. The following test was made by the writer. The kettle was arranged as shown in Fig. 6. It rested on a wooden bowl with a rope gasket between rim of bowl and kettle, and the steam supply was delivered through one ¾-inch pipe. The condensate was discharged out in the room through a short piece of ¾-inch pipe. The data taken on test was as follows:

Heating area of kettle	21.27 square feet
Steam pressure at boiler	70 pounds gage
Estimated moisture in steam	5 per cent
Temperature of condensate	212 degrees
Total amount of condensate	33 pounds
Pounds of milk in kettle	1560
Specific heat of milk	0.93
Initial temperature of milk	70.5 degrees
Final temperature of milk	90.0 degrees
Total time required to heat milk	8.5 minutes

Total heat absorbed by milk, 1,560 x 0.93 (90—70.5)= 28,291 B.t.u.

Total heat given up by steam and liquid, 33 (897 x 0.95)+ 33 (316—212)=31,553 B.t.u.

Thermal efficiency of kettle and pipe line,

$$=\frac{28,291}{31,553} \times 100=89.65 \text{ per cent.}$$

The total quantity of heat in the steam is practically the same just after it is discharged into the jacket as at the higher pressure in the supply pipe, but the temperature

may be considerably lower, for the reason that some of the heat contained in the steam goes to evaporating any moisture that may be present. Should the heat be in excess of that required to evaporate the moisture it goes to superheating the steam. In the case under consideration, however, the heat in the steam at 70 pounds pressure is just sufficient to evaporate the moisture at the lower pressure in the jacket and give dry, saturated steam at a temperature of 214 degrees. Since the discharge liquid is at 212 degrees the arithmetical mean temperature the jacket and milk was

$$t_m = \frac{212 + 214}{2} = 213 \text{ degrees}$$

The hyperbolic mean temperature difference between the jacket and milk was

$$T_m = \frac{(213-70)-(213-90)}{\log_e \frac{213-70}{213-90}} = 135.1 \text{ degrees}$$

The transmission of heat through the heating surface was 28,291 B.t.u. in 8½ minutes, or at the rate of 199,694 B.t.u. per hour; therefore,

$$U = \frac{199{,}694}{21.27 \times 135.1} = 69.5 \text{ B.t.u.}$$

Since the kettle was equipped with a stirring device U should be about 300. The low valve of "U" is obviously due to the small size of pipe supplying the steam to the jacket.

Test of a 6-foot vacuum pan:

Area of jacket	35.30 sq. ft.
Area of top coil	39.73 " "
Area of bottom coil	39.73 " "
Area of center coil	30.50 " "
Total area	145.26 " "

Time of operation	1.58 hours
Total weight of raw milk handled	8,436 pounds
Total weight of finished product	2,001.5 pounds
Total weight of water evaporated	6,434.5 pounds
Total weight of condensed steam (from coils and jacket)	7,224.0 pounds
Temperature of milk entering pan	140 degrees
Temperature of condensate from coils and jacket	212 degrees
Vacuum	24 inches
Pressure in coils and jacket	2.5 pounds
Pressure in boiler	113 pounds
Estimated moisture in steam from boiler	3 per cent

All the heating surface was not in use continuously. There was in operation

79.44 sq. ft. for 1.3 hours
30.50 sq. ft. for 1.58 hours
35.30 sq. ft. for 0.363 hours

The square foot hours service was

$$\begin{aligned} 79.44 \times 1.3 &= 103.272 \\ 30.50 \times 1.58 &= 48.190 \\ 35.30 \times 0.363 &= 12.814 \\ \text{Total} &\quad 164.276 \end{aligned}$$

The equivalent surface if operated continuously is (164.276÷1.58)=103.97 square feet.

The boiler pressure was reduced at the jacket and coils from 113 to 2½ pounds gage by throttling, hence practically all the heat in the steam at the higher pressure remained in the steam at the lower, going to superheat the steam at the lower pressure, and to evaporating any moisture that the steam may contain. Since the steam from the boiler was estimated to contain 3 per cent moisture, the excess heat at the lower pressure was sufficient to evaporate the contained moisture and, therefore, give dry saturated steam at the lower pressure of 2½ pounds gage.

The heat given up by the steam was

7,224 (965.3 + (220 — 212) = 7,031,119 B.t.u.

Heat absorbed in evaporating, 6,434.5 x 1,012.8=6,516,862 B.t.u.

$$\text{Thermal efficiency of pan} = \frac{6{,}516{,}862}{7{,}031{,}119} \times 100 = 92.7 \text{ per cent.}$$

The mean temperature difference between the steam in the coils and jacket and the evaporating liquid is 220—140.64=79.36 degrees.

$$U = \frac{7{,}031{,}119}{1.58 \times 104 \times 79.36} = 539$$

The concentration of the liquid was (8,436÷2,001.5)=4.21.
Pounds of steam at 113 pounds pressure per pound of finished product, (7,224÷2,001.5=3.6
Pounds of steam at 113 pounds pressure per pound of water evaporated, (7,224÷6,424.5)=1.12

Single Flow. In the single-flow type of heater, or pasteurizer, the heating medium is usually hot water. The water is heated by injecting steam directly into it and the quantity of steam is regulated so as to keep the water at approximately a constant temperature. The heating medium is practically stationary while the milk is caused to move over the heating surface in a thin film at a rapid rate. The milk generally enters at the bottom of the machine and is given a rapid whirling motion by means of a rotary paddle and leaves the machine near the top. The paddle serves to give the milk a high velocity over the heating surface and to wipe the surface, thus assisting in preventing burning or scorching. The wiping action of the paddle also serves to keep the heating surface bright and clean and hence increases the rate of heat transmission through the metal. The final temperature of the milk leaving the machine is regulated either by controlling the rate of flow to the machine or by controlling the temperature of the heating medium. Most of the so-called "flash" pasteurizers are of this type.

The action of this type of heater is illustrated in Fig. 1. The trend of the curve showing the temperature rise depends upon the quantity of milk flowing and the value of "U".

The following test was conducted by the writer on a popular type of flash pasteurizer:

Amount of 20 yer cent cream handled per hour	3,446 pounds
Initial temperature of cream	42 degrees
Final temperature of cream	169.6 degrees
Average temperature of water in jacket	196 degrees
Area of heating surface	8.25 sq. ft.
Specific heat of cream	0.91
Boiler pressure	70 pounds gage
Moisture in steam (assumed)	3 per cent
Pounds of steam used per hour	410

The steam was throttled at entrance to pasteurizer through a hand valve, consequently, the heat in the steam at boiler pressure is assumed to be delivered to the jacket water in pasteurizer.

The quantity of heat, Q, absorbed by the cream was

Q=3,446 x 0.91 (169.6—42)=400,136 B.t.u.

The quantity of heat, H, given up by the steam and liquid was

H=(410 x 0.97) 897.2 + 410 (316—196)=406,016 B.t.u.

The efficiency, E, of the apparatus was

$$E = \frac{400{,}136}{406{,}016} \times 100 = 98.5 \text{ per cent.}$$

The mean temperature difference, T_m, between the jacket water and milk was

$$T_m = \frac{(196-42)-(196-169.6)}{\log_e \frac{196-42}{196-169.6}} = 72.4 \text{ degrees}$$

$$U = \frac{400{,}136}{8.25 \times 72.4} = 669 \text{ B.t.u.}$$

Parallel Flow. The action of the parallel flow type of heater is shown in Fig. 3. The heater is of the double-pipe type consisting of a smaller inner pipe surrounded by a larger one. The milk flows through the inner pipe, and the heating medium, which is usually hot water, flows through the circular space between the outside of the inner tube and the inside of the outer tube.

In this arrangement of heater the coldest milk comes in contact, through the walls of the metal tubes, with the hottest water. As the distance from the entrance into the heater increases, the temperature of the milk rises while that of the water falls, the tendency being for both to approach the same temperature. Since the temperature difference between the two liquids rapidly diminishes, it is obvious that a temperature difference is soon reached where an excessively large heating surface is required for a small transfer of heat. If, however, it is intended to utilize only a relatively small part of the available temperature head, this arrangement may be used to advantage for the reason that less heating surface is required to produce the same results in the parallel flow as in some other arrangements.

If we assume that with a parallel current heater the milk enters at 50 degrees and leaves at 145 degrees, and that the water enters at 180 degrees and leaves at 150 degrees, then the mean temperature difference between the milk and water is

$$T_m = \frac{(180-50)-(150-145)}{\log_e \frac{180-50}{150-145}} = 38.36 \text{ degrees}$$

Since the milk is surrounded by the water practically no heat is lost from the milk; consequently, if we assume 5,000 pounds of milk heated through the stated range per hour the total quantity of heat absorbed by the milk is

$$Q = 5{,}000 \times 0.93\ (145-50) = 441{,}750 \text{ B.t.u.}$$

and the area of the heating surface required, assuming the coefficient of heat transfer as 200, is

$$A = \frac{441{,}750}{200 \times 38.36} = 57.6 \text{ square feet.}$$

Since the outer pipe, through which the hot water is circulated, is surrounded by air at a temperature considerably below that of the water, there will be a certain amount of heat lost through radiation from the pipes to the surrounding air. This loss will be about 5 per cent. Consequently, the quantity of heat given up by the water is

$$Q = 441{,}750 \times 1.05 = 463{,}838 \text{ B.t.u.}$$

and the total weight of hot water that must be circulated per hour at the temperature range specified is

$$W = \frac{463{,}838}{180-150} = 15{,}461 \text{ pounds}$$

In the parallel current heater, the heating medium must flow away at a temperature higher than the highest temperature attained by the liquid being heated. It is obvious, therefore, that a large volume of the heating medium is required, with a corresponding loss of heat. For this reason the parallel current heater is seldom used in practice, unless, as before stated, a large volume of the heating medium is available and it is only desired to utilize a small portion of the temperature head.

Counter Flow. The counter-current milk heater, or pasteurizer, is usually constructed of a series of pipes, one inside the other. The milk is usually pumped through the inner pipe and hot water through the annular space between the inner and outer pipes. The direction of flow of the two liquids is opposed to each other; that is, hot water enters at one end of the compound coil and the cold milk at the opposite end. This arrangement brings the hottest milk in contact, through the walls of the metal tubes, with the hottest water and the coldest milk with the coldest water. The arrangement is shown diagrammatically in Fig. 4, the arrows indicating the direction of flow of the two liquids. The relative quantities of the two liquids passed through the heater determine whether or not the curves representing the temperature changes converge, diverge, or are parallel. Should the curves representing the temperature parallel each other, the mean temperature difference between the two liquids is simply the difference between the thermometer readings at any point and may be found simply by subtracting the lesser from the corresponding greater temperature reading. It seldom occurs, however, that the curves are parallel, consequently the mean temperature between the two liquids is found by means of the formula already given. In practice it is customary to pump through considerably more water than milk, thus increasing the mean temperature difference and hence increasing the capacity of the apparatus.

On a test of an apparatus of this kind used as a pasteurizer, the following data were obtained:

Quantity of milk pasteurized per hour	7,000 pounds
Initial temperature of water	180 degrees
Final temperature of milk	145 degress
Quantity of water circulated	7,200 pounds
Initial temperature of water	180 degrees
Final temperature of water	90 degrees
Area of heating surface	80 sq. ft.

Heat absorbed by milk, $Q = 7{,}000 \times 0.93\ (145-50) = 618{,}450$ B.t.u.

Heat given up by water, $H = 7{,}200\ (180-90) = 648{,}000$ B.t.u.

Transfer efficiency of the apparatus

$$E = \frac{618{,}450}{648{,}000} \times 100 = 95.4 \text{ per cent}$$

The hyperbolic mean temperature difference between the milk and water was, $T_m = \dfrac{40-35}{\log_e \frac{40}{35}} = 38.16$ degrees, and the arithmetical mean temperature difference, $t_m = \dfrac{40+35}{2} =$ 37.50 degrees, a difference of only 0.66 degrees. In the counter current heater or cooler where the quantities of water and milk circulated are approximately equal, the arithmetical mean temperature difference gives results close enough for most practical purposes in the case of counter current heaters or coolers.

Using the arithmetical mean temperature difference between the milk and water, the coefficient of heat transfer is

$$U = \frac{618{,}450}{80 \times 37.5} = 206 \text{ B.t.u. per square foot per degree}$$

difference. The mean temperature difference between the water and the milk is considerably less in both the parallel and counter flow types than in the single-flow type, and the coefficient of heat transfer in the former types is a good deal less than in the latter. In the counter-current type it is possible to economize in hot water as an offset against the large heating surface required.

In the case of parallel currents the greatest temperature difference always occurs at the entrance to the apparatus, and the heating medium must always leave at a temperature higher than the highest temperature of the liquid being heated. Therefore, it follows that much more heating medium must be used in the case of parallel flow than with counter-flow apparatus.

In the case of counter-flow apparatus the heating medium may leave at a temperature only slightly above the entrance temperature of the cold liquid and the outlet temperature of the liquid being heated is usually considerably higher than the outlet temperature of the heating medium.

(To be continued in an early issue)

Cream and Milk Refrigeration Experiments[1]

By F. E. Price[2]

A STUDY of the effect of refrigeration and storage of cream on the farm upon the various factors of quality was made during 1929 at the Oregon Agricultural Experiment Station. Various methods of cooling and storing cream up to 90 hours were employed, and the resulting effect on bacterial count, flavor, odor and acidity was determined. Since the refrigeration of cream on the farm is largely an economic problem the cost of equipment and operating costs were major factors throughout the experiment.

This was a cooperative project between the Departments of Dairy Husbandry, Bacteriology and Agricultural Engineering. The cream grading was done by the dairy department, and the bacterial counts were made by the bacteriology department.

Economic Background. The economic background relating to this project may be of some interest. Oregon's export market for dairy products is becoming more discriminating as to quality. The bulk of the cream is produced on small dairies of probably 8 to 15 cows. Due to low quantity production and distance from the creamery, daily delivery often becomes costly. Most of the cream is held until sufficient volume has accumulated to justify delivery to market and unless refrigeration is employed the cream is of such low quality that it is impossible for the manufacturer to produce a high quality product.

This problem of quality is receiving considerable attention from the Buttermakers' Association of Oregon at the present time. There is a growing tendency for the creameries to buy cream on a quality basis with a graduated price scale. Approximately half of the creameries of Western Oregon are buying on a cream grade basis with a variation of from 3 to 5 cents per pound for butterfat.

The Oregon Agricultural College creamery is buying on a quality basis with a graduated price scale, with sweet cream butterfat receiving top price, a 3-cent reduction for No. 1 sour cream and an 8-cent reduction for No. 2 sour cream.

[1]Paper presented at meeting of the Pacific Coast Section of the American Society of Agricultural Engineers held during the Pacific Slope Dairy Exposition at Oakland, Calif., November 18, 1929.

[2]Project director, Oregon Committee on the Relation of Electricity to Agriculture. Assoc. Mem. A.S.A.E.

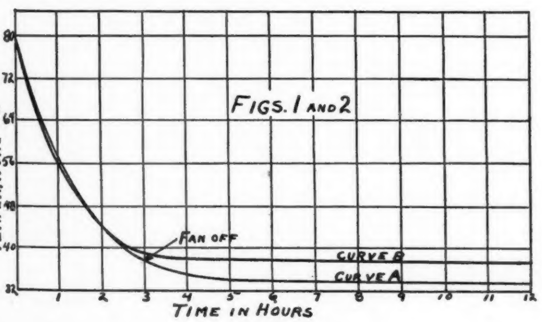


Fig. 1. Temperature graph of 3 gallons of 30 per cent butterfat cream. Cream held in dry chest (26 cu. ft. net) cooled by mechanical unit with forced air circulation for 3 hours. Box temperature, 30 to 38 degrees

Fig. 2. Same as Fig. 1, except that cream was held in refrigerated water. Water temperature, 35 degrees

Oregon Agricultural College cream grade standards are as follows:

Sweet Cream shall be understood to be cream that contains not in excess of 0.2 per cent lactic acid and is smooth, clean to the taste and free from foreign flavors and odors.

First Grade (sour) cream shall be understood to be cream not in excess of 0.7 per cent of lactic acid and is smooth, clean to the taste, and free from foreign flavors or odors. Butter from this cream should score 91 or better.

Second Grade cream shall be understood to be cream that is too high in acidity to grade as first, that may be foamy, yeasty, metallic, or contain foreign flavors and odors or either of them in a moderate degree, or is slightly stale and that is edible but does not meet the requirements of first grade cream.

The usual premium for good sweet cream for ice cream and restaurant trade is 5 to 10 cents per pound above market quotations on butterfat.

Equipment Used. Temperature measurements were made with copper-constanstan thermo-couples and a Type P Leeds-Northrup galvanometer. This allowed for temperature readings accurate to 0.1 degree (Fahrenheit). By using thermo-couples it was possible to keep the refrigerator door closed and take temperature readings without disturbing the conditions of the box or cream.

For the water storage tests an uninsulated galvanized iron tank, holding 50 gallons of water, was used. The water was changed morning and evening as the new cream was placed in the tank.

For the mechanical unit tests a chest type refrigerator with inside measurements of 60 by 36 by 28 inches deep was used. This box has three inches of cork insulation on the sides and botton with two inches of cork in the top. The insulation was put on in two courses with broken joints and sealed in hot asphaltum. The inside of the tank is of galvanized iron.

This box was designed to handle the milk or cream production for a small dairy of from 12 to 20 cows. It has a capacity of six 10-gallon cans or nine 5-gallon cans.

Two 58-F expansion coils with a 1-0 Frigidaire compressor was used in this experiment. The expansion coils are not of the proper dimensions for an efficient installation but were used, as coils of the correct dimension were not available.

The box was built in our shop for the purpose of determining construction problems and material costs. The tinsmith work connected with the metal lining was the only labor cost included.

Itemized Cost of Chest Type Refrigerator Box

Cork and cement	$24.02
Lumber	23.18
Galvanized lining	13.20
Hardware	4.53
Varnish	3.15
Total cost of material	$68.08
Tinsmith (labor)	14.40
Total	$82.48

For the ice storage tests a four-door, 40-cubic-feet (net) refrigerator was used. This box was built by the Oregon Committee on Relation of Electricity to Agriculture as a general-purpose refrigerator for the farm. It has a capa-

city of 400 pounds of ice, or a comparable electrical refrigeration unit. The lower compartments will hold six 5-gallon cans or four 10-gallon cans.

Storage Methods Studied.

1. Cream can in tank of 50 and 60-degree water changed twice daily
2. Refrigerator box cooled by ice
3. Refrigerator box cooled by mechanical unit dry method, natural baffle circulation
4. Refrigerator box cooled by mechanical unit, wet method
5. Refrigerator box cooled by mechanical unit, dry method using a fan for forced circulation

The maximum time for cream storage on the farm was taken as 90 hours, which provides for twice-a-week delivery plus 4 hours for time in transit. The cans of cream were held in the 80-degree room for 4 hours before delivery to allow for the average time in transit.

The cream used for this experiment was purchased from two farms having 8 cows each, and located near the college. The cream was sold to the college creamery at the end of each storage test. The average production for the 16 cows during the period reported was 14 pounds of butterfat per day. The cream was separated on the farm and transported to the laboratory within an hour. The storage room was kept at 80 degrees during the day and allowed to cool to about 60 degrees at night.

Cream Held in Tank Filled with 50-Degree Water Morning and Evening. In all of the tests the cream cooled to 80 degrees in delivery from the dairy to the laboratory. Three gallons of cream were poured into a 5-gallon cream can which was placed in the tank of 50-degree water. The cream cooled to 65 degrees in one hour, and in two hours dropped to 58 degrees, and the water raised to 55 degrees. The rate of cooling is shown graphically in Fig. 3, Curve D.

At the end of the 12-hour storage period the water raised to 60 degrees and the cream to 59 degrees. The cream was not stirred during the first 12 hours of storage.

Table II shows the acid reaction of the cream each day during storage. This shows that at 42 hours, or when it is shipped every other day during 80-degree temperatures, the oldest cream was slightly sour and the balance was sweet.

Table I shows the initial bacterial counts per cubic centimeter and the bacterial count at the end of the storage period.

Table II shows the cream grade each day during each storage test as determined by Dr. G. Wilster and E. S. Larrabee of the dairy department. This shows that cream held in a tank of 50-degree water graded "No. 1 sweet"

TABLE I. Average Bacterial Count per Cubic Centimeter (Cream Cooling and Storage)

Method of Cooling	Initial	18 hr.	42 hr.	66 hr.	90 hr.
50-degree (Fahrenheit) water	35,000		Sour	Sour	Excessive[3]
60-degree water	84,000		Sour	Excessive	
Ice (baffled circulation), 45 degrees	80,000	Excessive	Sour	Sour	Excessive
Mechanical Dry (baffled circulation), 34 degrees	25,000	1,000,000 to 2,000,000	400,000 to 800,000	1,500,000	Excessive
Mechanical Dry (fan circulation), 33 degrees	60,000	25,000	35,000	18,000	45,000
Mechanical Refrigerated Water, 35 degrees	30,000	170,000	21,000	70,000	500,00

[3]Above 2,000,000

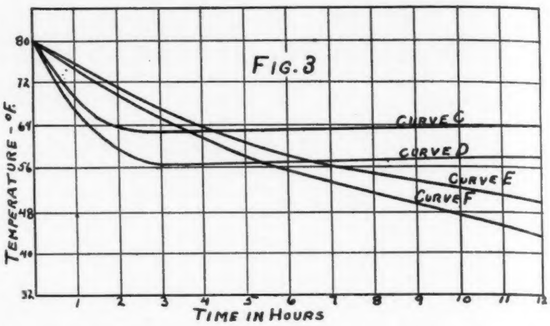


Fig. 3. Temperature graph of 3 gallons of 30 per cent butterfat cream: Curve C—60-degree tap water in an uninsulated 50-gallon tank; Curve D—50-degree tap water in an uninsulated 50-gallon tank; Curve E—Ice in 40 cubic foot box, at 45 degrees, good baffled circulation; Curve F—Mechanical unit, 26 cubic feet chest, dry storage, good baffled circulation, 34 degrees average box temperature. Room temperature, 80 degrees

at 18 hours and "No. 1 sour" at 42 to 66 hours, with a fair chance to grade "No. 1 sour" at 90 hours.

Cream Held in Tank Filled with 60-Degree Water Changed Morning and Evening. The rate of cooling is shown in Fig. 3, Curve C. After 2 hours the cream remained at 65 degrees.

The acidity advanced slightly faster in 60-degree water than when held in 50-degree water, but this was of little or no economic importance until it reached 66 hours, when the cream held in 60-degree water usually graded No. 2 sour. At 90 hours it was certain to grade "No. 2 sour" and have an acidity of 0.75 or more. Tables I and II give further data on this test.

Cream Held in Refrigerator Box Cooled with Ice (Average Box Temperature 45 to 50 degrees). The rate-of-cooling curve shown in Fig. 3, Curve E, shows that twelve hours were required to cool the cream to 50 degrees. This slow cooling permitted rapid bacterial growth.

Table II shows the acid reaction. The cream remained sweet for 42 hours with an acidity of 0.18, while at 66 hours the acidity was 0.23.

The cream graded "No. 1 sweet" for 42 hours and dropped to "No. 1 sour" at 66 hours and 90 hours.

TABLE II. Cream Grade and Acid Reaction (Cream Cooling and Storage)

Method of Cooling	6 hr.	18 hr.	42 hr.	66 hr.	90 hr.	114 hr.
50-degree Water—Grade	Sw	Sw	No. 1	No. 1	No. 1[4]	No. 2
Acid reaction[5]	.15	.16	.22	.44	.63	
60° degree F. Water—Grade	Sw	Sw	No. 1	No. 2	No. 2	
Acid reaction	.15	.16	.60	.85		
Ice (baffled circulation), 45 degrees—Grade	Sw	Sw	Sw	No. 1	No. 1	No. 1
Acid reaction	.15	.16	.18	.23	.30	
Mechanical Dry (baffled circulation), 34 degrees—Grade	Sw	Sw	Sw	Sw	Sw	Sw
Acid reaction	.15	.16	.16	.16	.16	.16
Mechanical Dry (fan circulation), 33 degrees—Grade	Sw	Sw	Sw	Sw	Sw	Sw
Acid reaction	.15	.16	.16	.16	.16	.16
Mechanical Refrigerated Water, 35 degrees—Grade	Sw	Sw	Sw	Sw	Sw	Sw
Acid reaction	.15	.16	.16	.16	.16	.16

NOTE 1: Sw—sweet cream
NOTE 2: No. 1—Grade No. 1 sour
NOTE 3: No. 2—Grade No. 2 sour
[4]On border line at No. 2—Sour
[5]Per cent of lactic acid

TABLE III. Method of Refrigeration—Dry Box (Baffle Circulation)

Average box temperature, 30 to 34 degrees Fahrenheit

Temperature of milk entering box, 65 to 67 degrees (surface cooled)

Bacterial grouping	No. of samples	Average of bacterial counts		Times increase	Times decrease
		Initial	Held 14 hr.		
0 5,000	36	4,070	3,808		0.06
5,001 10,000	75	7,430	7,780	0.04	
10,001 20,000	38	12,800	12,250		0.04
20,001 30,000	4	23,450	19,475		0.16
30,001 40,000	4	34,175	23,900		0.30

The temperature of the cream after 24 hours averaged 46 degrees.

Cream Held in Dry Chest Cooled by Mechanical Unit—Baffled Circulation. (Average chest temperature, 34 degrees). The compressor was set to give a chest temperature cycle of 28 to 40 degrees.

Fig. 3, Curve F, gives the rate of cooling for this method, which was only slightly faster than with ice. A special circular insulated baffle was used to check against the rate of cooling using no baffle, but only a slight difference was observed. Cooling by this method was very slow, taking 9 hours to reach 50 degrees, 12 hours to drop to 44 degrees, 24 hours to reach 40 degrees, and 48 hours to reach 35 degrees. The cream was not stirred during the first 12 hours.

The cause of the slow cooling was apparently due to the warm air blanket around the can and not due to lack of conduction inside the can. Thermo-couples placed ¼ inch from the outside of the cream can showed a temperature of 14 to 20 degrees higher than the average chest temperature during the first 12 hours. Thermo-couples placed in the center of the cream can and ¼ inch from the inside of the can showed a temperature difference of only 3 to 6 degrees while cooling from 80 to 40 degrees in 2½ hours, using forced circulation which kept the outside of the cream can within one degree of the chest temperature which was the most rapid method of cooling. In another special test 80-degree cream was cooled to 58 degrees in the center of the can in one hour and then thoroughly stirred and the temperature of the cream at the center of the can dropped only 0.4 degrees.

These tests show that stirring does not materially increase the rate of cooling of cream. This is somewhat contrary to usual dairy recommendations.

The bacterial count of the cream when cooled with a mechanical unit and baffled air circulation is shown in Table I. This shows the result of the slow cooling as there was a bacterial count of one to two million per cubic centimeter in 18 hours.

The bacterial count after 18 hours is rather interesting, as there is a consistent tendency for the bacteria to be reduced at 42 or 66 hours with a very distinct increase again at 90 hours. This indicates a dying-off of certain groups of bacteria and later growth of a different group of bacteria even though the cream was held at 36 degrees.

The acidity did not show an increase at 90 hours and the cream graded "No. 1 sweet."

Cream Held in Dry Chest Cooled by Mechanical Unit—Fan Circulation (Average chest temperature, 33 degrees.) This storage test was the same as the preceding one except that an 8-inch electric fan was used to increase circulation, particularly around the can of cream being cooled. The fan was set to operate for 3 hours after each can of cream was placed in the box and was stopped by a Big Ben alarm set to operate a tumble switch.

TABLE IV. Method of Refrigeration—Dry Box (Forced Air Circulation

Temperature of milk entering box, 65 to 67 degrees (surface cooled)

Bacterial grouping	No. of samples	Average of bacterial counts		Times decrease
		Initial	Held 14 hr.	
0 5,000	24	3,100	2,780	0.10
10,001 20,000	2	10,100	7,400	0.26

This method produced distinctly the best cream from the standpoint of bacterial count, finishing the 90-hour storage period with no growth of bacteria (Table I).

The rate of cooling is shown in Fig. 1, Curve A. The rate of cooling was practically the same for the first 2 hours by this method as by the refrigerated water method. However, the fan method cooled the cream to 36 degrees in 3 hours, and it reached 33 degrees in 12 hours, whereas the refrigerated water cooled the cream to only 40 degrees in 3 hours, and it reached 36 degrees in 12 hours.

Cream Held in Refrigerated Water in Chest Cooled by Mechanical Unit (Chest temperature, 35 to 37 degrees). The cream was cooled from 80 to 37 degrees in 4 hours by this method as shown in Fig. 2, Curve B. The cream reached 36 degrees in 12 hours and remained at that temperature during the remainder of the storage period. At 90 hours the cream scored "No. 1 sweet" with the taste fully equal to the same cream held for a shorter time. The cream testing was done by Dr. G. Wilster and E. S. Larrabee, specialists in cream grading of the dairy department. Prof. G. V. Copson, of the bacteriology department, reported an increase in bacterial growth in this test with the cream held at 36 degrees, averaging about 500,000 at 90 hours and occasionally reaching 1,000,000. This seemed rather confusing as we expected no bacterial increase at this temperature. Furthermore, we could not keep the water at a lower temperature due to the freezing of the water around the coils, without using an agitator.

There was a very distinct decrease in bacteria present at 30 hours to 42 hours with a pronounced increase in bacterial growth at 66 hours and 90 hours. A large number of special tests were made to verify this bacterial increase at 36 degrees, and the data showed the increase to be very consistent.

The acidity did not increase up to 114 hours, which was the longest storage time studied.

The refrigerated water or wet method has the advantage of fast cooling and makes possible the use of a smaller compressor, but can not be used conveniently for household refrigeration also.

The compressor was shut off for a period of 24 hours with no change of the water temperature. This fact makes possible the use of an engine-operated compressor where electricity is not available.

Cost of Operation. The power consumption for 27 days of mechanical refrigeration in the 26 cubic foot (net) box at 80 degrees room temperature was 42.6 kilowatt-hours, or 1.6 kilowatt-hours per day, which at 3 cents per kilowatt-hours would be 4.8 cents per day. Repairs and interest and depreciation on the box, compressor and coils will probably amount to 15 to 20 per cent of a $400 to $500 initial cost, or 20 to 25 cents per day. This would make a total cost of 25 to 30 cents per day.

The only rate of melting of ice data available at this time is on the 40 cubic foot box which is the large general farm refrigeration box which should be only partially

charged against the cream storage. The rate of melting for this box was approximately 2 pounds per hour.

Increased Dairy Income Per Day by Selling Sweet Cream

Number of cows	Pounds of butterfat per day	Premium per pound of butterfat per day for sweet cream				Gallons of cream produced per day	
		3c	5c	7c	10c	25 per cent butterfat	35 per cent butterfat
8	8	$ .24	$ .40	$ .56	$ .80	4.0	2.8
10	10	.30	.50	.70	1.00	5.0	3.5
12	12	.36	.60	.84	1.20	6.0	4.2
15	15	.45	.75	.95	1.50	7.5	5.2
20	20	.60	1.00	1.40	2.00	10.0	7.0
25	25	.75	1.25	1.75	2.50	12.5	8.7
30	30	.90	1.50	2.10	3.00	15.0	10.5
35	35	1.05	1.75	2.45	3.50	17.5	12.2

NOTE: A good cow will produce 1 pound of butterfat per day.

The foregoing table shows the increased daily income to dairies of 8 to 35 cows from the sale of sweet cream when receiving a premium of 3 to 10 cents per pound of butterfat above sour cream prices. The cost of refrigeration or daily delivery must stay within this margin and have a profit; otherwise the farmer will be ahead financially to market his butterfat as sour cream.

Mechanical refrigeration is being used on a dairy farm of 15 to 20 cows which is selling sweet cream and is located near the college. Records have been kept on the power consumption and production. The production for one year was 4860 pounds of butterfat. At a 5-cent premium for sweet cream the increased income for the year would amount to $243.00, and at a 3-cent premium, $145.80. This farmer actually received 5 and 7 cents premium for this sweet cream. The power consumption for the year was 642 kilowatt-hours, which at 3 cents would amount to $19.26. Interest and depreciation at 20 per cent on $400 would amount to $80.00 for the year, or a total expense of $99.26. The 5-cent premium would leave a $143.74 profit, and the 3-cent premium a $46.54 profit.

A new cream refrigeration experiment will begin within two months, which will involve mechanical refrigeration on two or three farms, taking the production of at least 50 cows. The cream will be shipped from the farms to the college creamery twice per week, where it will be churned in a commercial size churn and scored. A special study will be made of the bacterial flora found in the cream. This project should give definite information on the quality of butter that can be made from cream held three or four days at 40 degrees or less.

MILK REFRIGERATION ON THE FARM

Many producers of market milk who wholesale their product are interested in obtaining refrigeration with an installation less expensive than the walk-in type room and brine system now costing $1200 to $1500 or more.

TABLE V. Method of Refrigeration—Refrigerated Water Not Agitated

Average box temperature, 35 degrees. Milk cooled in 10-gallon cans

Temperature of milk entering box, 65 to 67 degrees (surfaced cooled)

Bacterial grouping	No. of samples	Average of bacterial counts: Initial	Held 12 hr.	Times increase	Times decrease
0 5,000	109	1,350	1,565	0.15	
5,001 10,000	12	6,340	9,130	0.44	
10,001 20,000	12	14,350	12,850		0.100

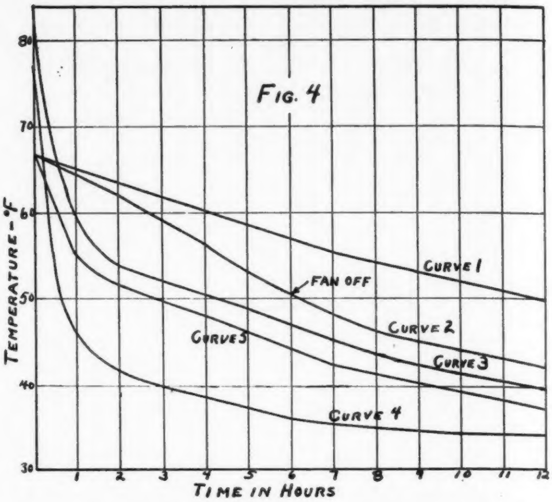


Fig. 4. Cooling curves of 10-gallon can of milk by various methods of refrigeration. Curve 1—Mechanical dry, natural circulation for 6 hours, box temperature 24 to 30 degrees. (Curves 1 and 2—milk cooled by surface cooler, not stirred while in box.) Curve 3 —Mechanical wet, water temperature 35 to 38 degrees. Curve 4—Mechanical wet, water agitated, water temperature 31 to 35 degrees. (Curves 3 and 4—Milk poured in cans suspended in refrigerated water, not surface cooled, milk stirred.) Curve 5—Mechanical wet, water temperature 35 to 38 degrees. Time to fill 10-gallon can, 15 to 25 minutes, 26 cubic feet (net) chest type box used. Unit, direct expansion used for these tests. The production was 80 to 100 gallons per day.

The type of equipment used in this experiment is available for about $500.

A milk refrigeration experiment was started in July 1929 at the Oregon Agricultural Experiment Station to obtain data on the performance of the chest type dairy refrigerator. The purpose of this project was to determine the rate of cooling of milk by various methods available when the milk is kept in 10-gallon milk cans on the farm for later delivery to market and to determine the bacterial growth during the first 12 to 14 hours.

This was a cooperative project between the departments of dairy husbandry, bacteriology, and agricultural engineering of the Oregon station.

The milk produced by the dairy department herd was

Equipment Used. The same ½-hp. compressor and expansion coils and the chest type box insulated with 3 inches of cork board as described in the previous section on cream refrigeration was used.

Temperature measurements were made with thermocouples previously described and Tycos recording thermometers.

TABLE VI. Method of Refrigeration—Refrigerated Water Agitated

Average box temperature, 32 degrees

Temperature of milk entering box, 55 to 60 degrees (surface cooled)

Bacterial grouping	No. of samples	Average of bacterial counts: Initial	Held 12 hr.	Times increase	Times decrease
0 5,000	96	2,600	3,035	0.16	
5,001 10,000	46	6.600	6,330		0.40
10,001 20,000	6	13,900	10,116		0.272
20 001 30 000	2	22,000	29,700	0.30	

TABLE VII. Method of Refrigeration—Open Tank (Tap Water)
Average box temperature, 60 degrees
Temperature of milk entering box, 55 to 60 degrees

Bacterial grouping	No. of samples	Average of bacterial counts			Times increase	
		Initial	Held 12 hr.	Held 24 hr.	12 hr.	24 hr.
0 5,000	46	1,930	5,570	88,500	1.89	44.70
5,001 10,000	2	6,950	28,500	89,000	2.67	10.35
10,001 20,000	4	14,800	51,025	750,000	2.45	49.70

Storage Methods Studied.

1. Expansion coils in the dry box milk precooled to 65 to 67 degrees over aerator using tap water—forced circulation
2. Refrigerated water: (a) Milk precooled to 65 to 67 degrees over aerator, using tap water; (b) milk put in cans at 95 degrees
3. Refrigerated water agitated—milk precooled to 55 to 65 degrees over aerator.

The refrigerator box was placed in the milk room adjacent to the dairy barn at the college similar to a farm set-up. The milk was held 12 to 14 hours in the refrigerator, which is usually the maximum time milk is held on the farm.

Bacterial samples were taken as soon as the cans were filled to determine the initial count and another set of samples were taken 12 to 14 hours later when the milk was shipped.

Results Obtained. The milk that was placed in the dry box was precooled to 65 to 67 degrees over a surface cooler or aerator using tap water. The rate of cooling in the refrigerator, which maintained a temperature of 34 degrees, was rather slow as would be expected. This is shown in Fig. 4. With baffled circulation the milk cools about 1½ degrees per hour reaching 50 degrees in 12 hours.

Using a fan for forced circulation the milk cooled to 52 degrees in six hours, and to 42 degrees in 12 hours.

The fact that this dry storage was tried does not mean that it is being advocated.

The bacterial data is given in tabular form in Tables III and IV, showing 36 cans of milk with initial counts of less than 5000 per cubic centimeter averaged 4070 and at 14 hours had an average count of 3808, or a slight decrease. There were 75 samples with initial bacterial counts of 5,000 to 10,000 per cubic centimeter that averaged 7,430 per cubic centimeter and at 14 hours

TABLE VIII. Method of Refrigeration—Wet Mechanical
Average box temperature, 35 degrees
Temperature of milk entering box, 95 degrees

Bacterial grouping	No. of samples	Average of bacterial counts		Times increase	Times decrease
		Initial	Held 14 hr.		
0 5,000	97	2,080	2,530	0.207	

averaged 7,780 per cubic centimeter. There were also 38 cans of milk with counts of 10,000 to 20,000 per cubic centimeter that averaged 12,800 as initial counts and 12,500 at 14 hours, or a slight decrease again.

The increase or decrease of bacteria in each of the three groups is so slight as to probably be within experimental error.

Refrigerated water was used, both agitated and not agitated, and milk at 95 degrees was poured in the 10-gallon cans while they sat in the water, and in another series of tests the milk was cooled to 65 to 67 degrees over a surface cooler, using tap water, before being put in the refrigerated water for further cooling and storage.

The different rates of cooling are shown in Fig. 4. The 95-degree milk cooled to 60 degrees in 1 hour, 54 degrees in 2 hours, 52 degrees in 3 hours, and 40 degrees in 12 hours, in still water. The water temperature was 35 degrees at the beginning when the milk was placed in the box.

When the milk was precooled at 67 degrees, it cooled to 55 degrees in one hour, 50 degrees in three hours, and 37 degrees in 12 hours, in non-agitated water.

The water was agitated gy a small propeller with a shaft extending through the side of the box and driven by a ¼-hp. motor. The water temperature then lowered to 30 to 32 degrees. Milk precooled to 68 degrees before being placed in the agitated water, cooled to 50 degrees in 30 minutes in the center of the can and the average temperature of the milk determined by stirring at 30 minutes was 46 degrees. In one hour the milk dropped to below 45 degrees when not stirred.

The bacterial data for the refrigerated water methods is given in tabular form in Tables V and VI. In the limited time available a brief statement of the difference in bacterial counts of the initial samples and the samples taken 12 hours later would probably be that the slight difference, whether an increase or decrease, is well within the range of experimental error.

Milk that was cooled over a surface cooler to 60 degrees and held in 60-degree water increased in bacterial count from 1930 to 5570 per cubic centimeter in 12 hours and to 88,500 in 24 hours.

The Balkan States as a Market for American Products and Capital

DURING the World War and for a few years following it American manufacturers of farm machinery and of chemical products used in agriculture found a ready market in western Europe. The native industries of that part of Europe had largely been destroyed by the war. In course of time, however, these industries began to recover and soon they were not only able to meet the demand of their home markets, but to produce a surplus for export as well. This made western Europe less of a market for American products. American manufacturers next directed their major attention to eastern Europe and the economic program of Soviet Russia.

One market which the farm implement and chemical manufacturers seem to have overlooked so far is in the Balkan states. These countries, Yugoslavia, Bulgaria and Albania are rich in natural resources, and have a population of more than 30,000,000; but until the end of the World War they were handicapped by Turkish tyranny.

Now these countries are free; enjoy stable government and a sound financial situation; and are in an era of economic reconstruction. The population is 90 per cent agricultural and their governments are making efforts to modernize their agriculture.

Germany and Italy are entering this new market, but the people seem to prefer American products when they can get them. They look forward to receiving more of our products, as well as our capital, and offer all possible guarantees for the success of our export ventures and investments. No time should be lost in winning these excellent markets for American products. — Nicholas Kaperceff

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

The Results and Significance of the Spur (Texas) Run-Off and Erosion Experiments, R. E. Dickson (Journal of American Society of Agronomy (Geneva, N. Y.) 21 (1929), No. 4, pp. 415-422).—A description is given of the run-off and erosion experiments being conducted by the Texas Experiment Station at the Spur Substation, and the progress results are reported.

The project embraces a series of eight small control plats, 1/75 acre in size, being 6 feet wide and 96.8 feet long. They are bordered with heavy galvanized iron having calibrated concrete tanks at the lower ends with sufficient capacity to hold the water lost and the soil eroded during the heaviest rain periods. In addition to the control plats in the layout of this experiment there are 10 field areas, each being approximately 10 acres in size. At the lower corner of six of these areas is a concrete weir and an automatic water stage recorder which furnishes a definite measure of the amount of water that passes from the area. Two other field areas are terraced so as to hold all of the water that falls on them, and the remaining two hold all of the water that falls on the land and an additional measured amount that comes as run-off losses from other areas.

The experiments on the effect of slope on water losses from land planted to cotton showed that in each of three years the level plat had comparatively small water losses or about one-fifth as much as the plat with a 1 per cent grade. The same relative difference does not exist between the plats with a 1 and 2 per cent grade, the difference in the water losses being small and fairly consistent through the three years. This indicates rather clearly that it does not require much of a slope for water to flow off the land. Probably the greatest beneficial results can be secured by water conservation practices and at a minimum cost on comparatively level land.

The experiments on the effect of crop on water losses showed that Buffalo grass has been the most effective crop in preventing water losses and since becoming fully sodded has been practically perfect in preventing run-off. There is little cause to question the fact that the water losses from grazing land have been materially increased by overpasturing and that this practice has resulted in the destruction of this natural obstruction to water movement. There is also much evidence that the milo plant, acting as a cover crop while growing and later furnishing a large plant litter, is far superior to cotton in preventing run-off water losses.

In experiments with the effect of tillage on water losses a fallow plat spaded to a depth of 4 inches in the winter lost a little more than one-half as much water in 1927 and 1928 as a fallow plat not spaded or cultivated but which had the weeds removed with a hoe. It appears from the measurements of losses occurring, and also from other observations made during the three years, that cultural methods can be improved in handling row crops so as to maintain the surface soil in a better condition to prevent run-off water losses. Recent experiments on the effects of cultivation show conclusively that the greatest beneficial result is the destruction of weeds whose growth makes heavy drafts on the moisture and available plant food supply. It thus appears that tillage studies having for their objective the prevention of water losses are needed.

It was also found that soil losses from the control plats are highly correlated with the water losses. Soil eroded and carried to the pits with each 1,000 gallons of water has been approximately the same for the various plats. It appears that water and soil losses are concemitant and that any practice that accentuates water movement from the land at the same time creates an accelerated soil movement in the same direction.

The field terracing results appear to be in favor of the level terraces as regards crop yields.

Irrigation Districts in California, F. Adams (California Department of Public Works, Division of Engineering and Irrigation (Sacramento) Bulletin 21 (1929), pp. 421, pls. 31, figs. 10).—The results of an investigation of irrigation districts and the irrigation district movement in California are reported, which was conducted cooperatively by the California Experiment Station, the U.S.D.A. Bureau of Public Roads, and the California Department of Public Works. Chapters are included on forms of districts for irrigation or water conservation authorized by California statutes, the irrigation district movement in California since 1897, development of the California irrigation district law since 1897, active California irrigation districts, inactive or partially active irrigation districts, and status of districts organized for irrigation or water conservation other than irrigation districts.

The conclusion is drawn that the essential principles of the California irrigation district law are sound and workable, and that State administrative control of irrigation district organization and financing, as evolved in California during the last two decades, is stabilizing irrigation development in the State.

"No irrigation district can afford to lay out its irrigation system or construct its works without the advice of a professional engineer in each important phase of the work to be undertaken. This is true not only of the main construction, but also of the less important engineering features, and the agricultural economic problems involved.

"Irrigation districts primarily promoted by others than the owners of the lands to be directly benefited, require special scrutiny at the hands of reviewing authorities. It is not important who initiates an irrigation district project, but it is important that the landowners within the proposed enterprise shall from the beginning exercise guiding control in its organization and development; also that the problems of those who are to farm the land to be benefited shall be given their due consideration in connection with the indebtedness and operating charges that are incurred."

Water Carried for Household Purposes on Nebraska Farms, M. R. Clark and G. Gray (Nebraska Station (Lincoln) Bulletin 234 (1929), pp. 22, figs. 4).—Results of a survey of the amount of water carried for household purposes on Nebraska farms are summarized. No relationship was found between the person carrying water and the number of persons in the household. Cream separators were found to create a demand for water peculiar to the farm home. An average of 178.8 gallons of water was used by each household, or an average of 41.1 gallons per person per week and 5.9 gallons per person per day. Water used for general household purposes was carried an average distance of 75.7 feet and that used in the laundry an average distance of 62.6 feet. Each week an average distance of 4,311.5 feet was traveled in carrying water in each household The time consumed by each household in this work was on the average 2 hours and 20 minutes per week for general household purposes and 46 minutes for laundry purposes.

Report of the Royal Commission on Land Drainage in England and Wales, Lord Bledisloe Et Al. (London: Government, 1927, pp. 60, pl. 1).—This is the report of a commission appointed to inquire into the present law relating to land drainage in England and Wales and its administration. The recommendations arising from this inquiry indicate the desirability of consolidating and amending the law, with particular reference to the formulation of what corresponds to drainage districts in America.

Book Review

"High Humidity Tests on Wood Exterior Refrigerators" is a recent addition to the "Wood Fabrication Series" of bulletins published by the National Lumber Manufacturers Association. It has been prepared primarily to bring to the attention of refrigerator manufacturers the most recent information on wood box construction. Results of laboratory tests and field investigations are reported in detail. The address of the Association is Transportation Building, Washington, D. C.

"The Do-Well Farm Record Book" published by the Do-Well Agricultural Service, Champaign, Illinois, gives several pages of basic information on record keeping and successful farming, followed by ruled pages sufficient for keeping reasonably complete farm records for diversified farming for one year. Space is provided for a drawing of the farm; crop records; egg and milk production records; inventory expense, or income and expense accounts for farm repairs, fertilizer, trucks, autos and tractors, other machinery and equipment, labor, veterinary, feed and concentrates, sheep, horses and mules, hogs, cattle, dairy produce, sheep and wool, poultry and eggs, grain, miscellaneous crops, and other miscellaneous expense and income; summary of receipts and disbursements; records of accounts, notes and mortgages, payable and receivable; balance sheet for the beginning and closing of the year; and a breeding record. The price of the book is $1.00 in the United States.

A CORRECTION

In the review of "Farm Machinery and Equipment," by H. P. Smith which appeared in this column of the November 1929 issue the list price was incorrectly stated. The price is $3.25.

Who's Who in Agricultural Engineering


J. A. King


H. H. Musselman


F. P. Cartwright


E. R. Meacham

J. A. King

James Alexander King (Mem. A.S.A.E.) is advertising and publicity manager for the Mason City Brick & Tile Company of Mason City, Iowa. Since receiving a bachelor of science degree from Simpson College in 1902 he has enjoyed a varied experience, including two years of high school teaching, during which time he organized and initiated the first course in agriculture in any Iowa high school; two years in command of a company of native troops in the Philippines; two years in farm crops extension work at Iowa State College; two and one-half years with the Hart-Parr Company in charge of field experiments and educational work; three years as editor of "The Farming Business" and consulting editor of "Farm Engineering," early power farming periodicals; and since 1918, his present position, with the exception that in 1923 he served as editor and business manager of "National Reclamation Magazine." During this time he has done a great deal of writing on tractor farming, tile drainage and farm buildings for the farm and technical press. The second edition of his book, "Tile Drainage," is exhausted and a third edition is soon to be published. He has been active in the Society since 1910.

H. H. Musselman

Harry Hayes Musselman (Mem. A.S.A.E.) is professor and head of the agricultural engineering department at Michigan State College, where he graduated in civil engineering in 1908. After two years on the home farm and in structural steel work and structural drafting at Detroit, Michigan, he returned to his alma mater in the fall of 1910 as instructor in farm mechanics. His early life was spent on a newly settled farm in Paulding County, Ohio, where practically every field of agricultural engineering presented real problems. This early interest had no small part in determining his choice of college work and career, even before agricultural engineering came to be dimly recognized as a possible profession. He has been identified with the Society since 1911, serving at its president in 1915. During the war he was in charge of instruction in tractors for military training units at Michigan State College, in addition to his regular work. The year of 1920 was spent at Camp Grant, Illinois, as development specialist in automotive instruction on a plan to introduce educational advantages to the peace-time army. Among his interests has been the development of the marl resources of the state, where its use as a liming agent is needed.

F. P. Cartwright

Frank Poole Cartwright (Mem. A.S.A.E.) is chief engineer for the National Lumber Manufacturers Association, in charge of its construction research program and consultant on the use of lumber in structures. It is this work that first brought him in active contact with agricultural engineering problems, and resulted in his becoming a member of this Society in 1927. His previous professional record includes receiving the degree of civil engineer from Cornell University in 1913; several months as assistant engineer for the New York State Highway Commission; about three years in successive positions as draftsman for the Turner Construction Company, the B. R. & P. Railway, and the Rochester (New York) Gas & Electric Corp.; three years on the staff of the Rochester Bureau of Municipal Research; another year on the staff of the Cleveland Municipal Research Bureau; and five years as technical secretary of the U. S. Department of Commerce Building Code Committee. In 1926 he left that position to take up his present work. He has taken an active interest in the Structures Division of the Society, and is a member of the recently organized U.S.D.A. Advisory Council on Structures Research.

E. R. Meacham

Elmer Reynolds Meacham (Mem. A.S.A.E.) is manager of the rural electric service department of the Wisconsin Power and Light Company. He entered the University of Wisconsin in 1915, but the war interrupted his studies and delayed his graduation until 1920, when he received a bachelor's degree in agriculture, with a major in agricultural engineering. Then he became assistant professor in charge of farm machinery, under the administration of the agronomy department, at Clemson Agricultural College. After two years, however, he returned to the University of Wisconsin to take an assistantship in the department of agricultural engineering and to work for a master's degree. This was granted in 1924. Through election to an industrial fellowship in the department he became the first leader of Wisconsin's rural electric project. As such he had charge of and did much of the work in the initial development of the experimental power line at Ripon. Since 1925 he has held his present position. He has written many popular articles on rural electrification and has also been active in the rural service work of the Wisconsin Utilities Association and the National Electric Light Association.

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

PUBLICATIONS COMMITTEE

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The Society is not responsible for the statements and opinions contained in the papers and discussions published in this journal. They represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

Dairy Engineering

THE Committee on Dairy Engineering of the American Society of Agricultural Engineers was appointed in 1927 to (1) promote more widespread interest in and appreciation of the engineering phases of dairy production and manufacturing, (2) provide a point of contact for engineers in that field, (3) organize such technical activities as are deemed essential to sensible development in dairy engineering, (4) correlate this development with that in other branches of agricultural engineering and (5) promote more extensive research work in dairy engineering.

Meetings in conjunction with the Pacific Slope Dairy Show, and more recently with the National Dairy Industries Exposition, are the principal technical activities used thus far in promoting the desired interest, contacts and development. The publication in AGRICULTURAL ENGINEERING of papers presented at such meetings is further promoting these interests and is laying the foundation for a closer correlation between dairy engineering and other branches of agricultural engineering. The number of dairy engineers who have applied for membership in the Society is also sufficient to become an important factor in correlating dairy engineering and other branches of agricultural engineering.

Before the Committee was appointed dairy engineers had not found an organization into which their technical interests fit naturally and comfortably. The dairy interests were well organized but were occupied with other than engineering problems. And while the older engineering societies had engineering viewpoint most of their members were likewise engrossed with other problems.

In a few of the state agricultural colleges, however, dairy engineering was recognized and administered as a branch of the agricultural engineering department. A. W. Farrall, as junior agricultural engineer specializing in dairy engineering research at the University of California, saw dairy engineering as a branch of the application of engineering to agricultural production and processing. He tackled the job of getting it recognized as such by the Society and of interesting other dairy engineers in the Society. Accomplishments in this direction are a credit to him and his committee.

Processing Agricultural Products

WHERE would a line fence logically separate agricultural engineering from other fields in the matter of processing agricultural products? Emphasis being given by the American Society of Agricultural Engineers to dairy engineering forces the question.

Agricultural engineering is enjoying apparent success in adopting dairy engineering as one of its branches. It is doubtful, however, if it could or would want to adopt as its own the engineers and engineering problems of, for instance, the textile industry. It is therefore impossible to answer the question by simply saying that the processing of agricultural products does or does not involve agricultural engineering problems. Some principles are needed to guide the profession in prospecting and staking out its claims in the processing industries.

Determining factors upon which such principles should be based would include the prior art involved. As agricultural engineers we should be sure there is a real opportunity and need for our services before trying to apply them in an industry older than our own profession as, for example, the textile and meat packing industries. On the other hand, an industry which outgrew the farm as a result of agricultural engineering development would probably still continue to be a field for agricultural engineering activities.

Applicability of agricultural engineering subject matter, technique and equipment are also important considerations limiting and directing the expansion of our profession. The industrial utilization of crop wastes furnishes an illustration. We are probably better equipped than any other group to handle any problems that arise in the harvesting and delivery of crop residues. But there our function definitely ends. It would be impracticable for us to diversify our efforts and knowledge to cover the chemical treatment of the materials.

Especially is this true in view of the fact that chemical engineers are making satisfactory progress in the treatment of farm wastes. Where, as in this case, another group with a technique of its own is involved, a spirit of cooperation rather than a short-sighted professional loyalty and ambition must influence the decision of agricultural engineers as to the part we will take. A small technical group with similar subject matter and technique and which does not belong to some larger organization, may with mutual benefit be adopted as a part of the profession. With larger bodies a mutual understanding, joint committee or other working agreement should serve to accomplish the desired results.

The part played by our profession in the farm production and preservation of any given commodity will influence the part we will play in its processing. Equipment and technique developed and data and experience gained in the control of physical conditions affecting a commodity on the farm, will be advantageous in its processing. Other conditions being favorable, it will be most logical for us to engineer the processing of the products which we have helped most to produce and preserve on the farm. Particularly the more perishable farm commodities may warrant agricultural engineers following through with their control of physical conditions until the products reach the consumer or have been rendered less perishable.

It should be remembered also that the larger and more widespread the industry, the greater the opportunities it offers for professional activities. Industries in which only a few plants turn out the national production, either large or small, are more appropriate fields for the attention of individual genius.

Judged on the basis of these considerations dairy engineering is logically a branch of agricultural engineering and our profession is justified in the aggressive action it has taken in promoting the recognition of this fact.

A. S. A. E. and Related Activities

Power and Machinery, Structures and Rural Electric Division Meetings Draw Large Attendance

COMMENTS on the three overlapping technical division meetings of the American Society of Agricultural Engineers held at the Hotel Sherman, Chicago, December 2 to 5, indicate that they surpassed all previous meetings of these Divisions. The total of 307 registrations set a new attendance record. Each of the Division meettings opened with a short talk by W. G. Kaiser, president of the Society.

Papers by John S. Bird, president of the Wheat Farming Company; Hickman Price, wheat grower; and E. G. McKibben, associate professor of agricultural engineering at Iowa State College, fulfilled the expectations of the first-morning audience of nearly 100 who where interested in large-scale farming. Many of this group felt, however, that the subject warranted more time. D. Howard Doane, of Doane Agricultural Service, expressed their wishes to the Council at its meeting that evening, with the result that the Power and Machinery Division is scheduled for a three-day meeting next winter, one day of which will be given to large-scale farming and farm management.

Progress and problems of research, design and application were presented at the general-purpose tractor symposium on the afternoon of the first day. The prevailing sentiment seems to be that there are many more problems to be solved and that considerable further improvement and even a wider field of application than at present may be expected for the general-purpose tractor of the future.

Committee reports heard on the evening of the first day evoked considerable discussion, particularly Chairman H. B. Josephson's report for the Committee on Hay and Forage Crop Drying. Mr. Josephson is engineer in charge of research in farm machinery at Pennsylvania State College. His commitee is making substantial progress in its studies. and interest in the matter of crop drying is increasing as investigations along that line proceed, as indicated by the discussion.

Dr. E. L. Nixon, professor of plant pathology research at Pennsylvania State College, better known as the ruling mind and spirit of Pennsylvania's prosperous potato-growing industry, was a feature on the second day's program. In an informal talk which allowed full expression of his magnetic personality, he brought out the "Feature Requirements of Potato Machinery" through an exposition of the methods by which 400-bushel yields are obtained and by a good-humored but forceful citation of some of the mistakes and failures of farm implement manufacturers.

Other papers which presented the viewpoints of metallurgists and a soil scientist on farm machinery problems, and papers on the farm transportation problem and on weed control were well received.

The paper on power take-off standardization by W. L. Zink, engineer for the General Implement Company and leading reformist on power take-off standards, was a starter for a conference on the subject the following day. At that conference engineers representing the interested manufacturers cut up the present standards and tossed them into the pot along with their present knowledge and prejudices on the subject; stirred and evaporated this brew for several hours; and finally crystallized out a new set of standards for the scrutiny and approval of the Society.

With a big score chalked up in its favor in the form of the U.S.D.A. farm building research investigation now under way, the Structures Division reflected in its program a new sense of assurance. Their morale raised, the farm structures men heard the scheduled papers on the farm home, grain storage, floor heating, the dairy barn questionnaire, and the standard milk control code, and entered into the discussions with renewed interest. Henry Giese, senior agricultural engineer, specially appointed by the U.S.D.A. to conduct the investigation, was present to tell about the things he has learned thus far of "The Farm Building Research Situation."

The papers scheduled by the Rural Electric Division to bring out new information on the use of electricity in dairying, poultry production, feed grinding, underground wiring and electric hotbeds, drew a large attendance of project leaders, rural service men and manufacturers' representatives. Several of the subjects were handled by two or more men, each presenting a prepared discussion giving his own viewpoint and experiences. Geo. W. Kable, director of the National Rural Electric Project, in leading the concluding event on the program, had each state project leader present report briefly on any new developments on his project.

An innovation of the meeting was the joint session of the Rural Electric and Structures Divisions to hear a paper by J. L. Strahan, agricultural engineer, Louden Machinery Company, on "The Use of Electric Power for Ventilating Stables."

Members and guests of the North Atlantic Section, A.S.A.E., at its meeting at Amherst, Mass.

Noon luncheons were held in one of the meeting rooms each day as usual. A number of unscheduled papers and talks were presented during the four days as extra-program features. L. J. Fletcher, agricultural engineer, Caterpillar Tractor Company, and J. B. Davidson, head of the department of agricultural engineering at Iowa State College, talked on things Soviet. An unusual number of moving picture films and slides were available for illustrating papers presented.

Praise is due the men who wielded the gavel for the various sessions and who were largely responsible for the success of the programs. They were R. U. Blasingame, chairman of the Power and Machinery Division, J. L. Strahan, chairman of the Structures Division, E. E. Brackett, chairman of the Rural Electric Division; Geo. W. Iverson, acting chairman for the committtee reports session; Col. O. B. Zimmerman acting chairman for the standards conference; and Geo. W. Kable, acting chairman for the project leaders session.

PROGRAM

Meeting of the

Southern and Southwestern Sections

American Society of Agricultural Engineers

Held in Conjunction With a Meeting of the Southern Agricultural Workers' Association

Jackson, Miss., Feb. 5, 6 and 7, 1930

Afternoon — 2:00 p.m. — Wednesday, February 5

1. "Changes Which are Being Brought About in Agriculture" —W. G. Kaiser, president, American Society of Agricultural Engineers
2. "Economics of Agricultural Engineering"—Speaker to be selected
3. "Research in Farm Structures" — Henry Giese, agricultural engineer, Division of Agricultural Engineering, U.S.D.A.
4. "Progress in Cotton Fiber Studies"—Dr. R. W. Webb, division of cotton marketing, Bureau of Agricultural Economics, U.S.D.A.
5. "Cotton Drying and Progress in Cotton Ginning Research"—C. A. Bennett, associate mechanical engineer, Division of Agricultural Engineering, U.S.D.A.

Afternoon — 2:00 p.m. — Thursday, February 6

1. "Power Farming in the Southeast" — J. T. McAlister, extension agricultural engineer, Clemson Agricultural College
2. "Machinery for Cotton Production in the Central South (Results of Tests)" — J. O. Smith, agricultural engineer, Mississippi Delta Experiment Station
3. "The Combine in the South for Harvesting Grain and Soybeans" — W. C. Howell, professor of agricultural engineering, Mississippi A. & M. College
4. "Hay Drying Tests in Louisiana"—H. T. Barr, associate in agricultural engineering, Louisiana State University
5. "Farm Home Planning"—Mary E. Keown, district home demonstration agent, University of Florida

Afternoon — 2:00 p.m. -- Friday, February 7

1. "Terracing Pointers" — J. T. Copeland, extension agricultural engineer, Mississippi A. & M. College
2. "Soil Dynamics Problems" — M. L. Nichols, professor of agricultural engineering, Alabama Polytechnic Institute
3. "The Relation of Electrically Operated Refrigeration Equipment to Southern Agriculture" — E. C. Easter, agricultural engineer, Alabama Power Company
4. "Progress of Rural Development in the South" — C. L. Osterberger, agricultural engineer, Louisiana Power & Light Company

Pacific Coast Section Announces Meeting

THE annual meeting and election of officers of the Pacific Coast Section of the A.S.A.E. will be held in the Agricultural Engineering Building, at Davis, Calif., January 27.

W. L. Paul, acting chairman of the Section, will call the meeting to order and W. L. Howard, director of the branch of the college of agriculture, University of California, will give the address of welcome.

Soil and the agricultural engineering problems it involves will be the topic of the day. Papers and discussions are slated on the subjects, "Soil Moisture and its Relation to Cultivation and Plant Growth," "Rainfall Penetration Studies in Southern California," "The Engineer's Interest in Tillage Research," and "Rotary Plows."

A cafeteria luncheon followed by the annual business meeting and election of officers will add varieety to the program. At a 6 o'clock dinner which will conclude the meeting, L. J. Fletcher, agricultural engineer, Caterpillar Tractor Company, will tell about his experiences in the Soviet Union last summer.

Reclamation Division Holds Successful Meeting

IT SEEMED to be practically the unanimous opinion of those present that the meeting of the Land Reclamation Division of the American Society of Agricultural Engineers at Kansas City, December 30 and 31, was an unqualified success. It is the first technical meeting the Division has sponsored separately from the annual meetings of the Society. An attendance of 75 persons was registered with possibly a total attendance of close to 100.

The keynote of the meeting may perhaps be best expressed in the proposed plank on land reclamation for the Society's platform which during the meeting was drafted, approved and recommended to the Society for adoption. This plank reads as follows:

> "WHEREAS land reclamation, as advocated by the American Society of Agricultural Engineers, involves putting agricultural land to best use in which it will render the largest possible benefits to both owner and the general public—whether it be for producing crops or furnishing recreation—and increasing the benefits to be obtained by the proper use of that land to the highest point commensurate with the cost involved, the Society therefore favors all forms of land reclamation consistent with the foregoing conception."

The program was presented practically as scheduled and published in the December issue of this journal. The first day was devoted to simultaneous sessions of the four main groups of the Land Reclamation Division, namely, soil erosion control, drainage, irrigation and land clearing.

The soil erosion control session was featured by a paper on the soil erosion control work on the Guthrie (Oklahoma) project, presented by C. E. Ramser, senior drainage engineer of the U. S. Department of Agriculture; a paper by C. K. Shedd, extension agricultural engineer of the University of Missouri, on terracing problems in the corn belt states; a paper on the late developments for the prevention of soil erosion in Mississippi by J. T. Copeland, extension agricultural engineer of the Mississippi A. & M. College; and by a paper presented by G. E. Martin, agricultural engineering specialist of the Oklahoma A. & M. College, outlining a statewide program for extension work in soil erosion control. The presentation of these papers was followed by roundtable discussions of soil erosion control problems. Mr. Martin presided at this session.

At the irrigation session, with M. R. Lewis, irrigation engineer, Oregon State College, presiding, papers were presented by Dr. Hugh A. Brown, director of reclamation economics, U. S. Department of the Interior, of the work of the Bureau of Reclamation in providing supplemental water for irrigation, by J. C. Russel, professor of agronomy of the University of Nebraska, on the relation of length of drought periods to the need of irrigation, by E. H. Neal, irrigationist, University of Idaho, on the use of deep wells and pumps for drainage and supplemental irrigation water, and by F. E. Staebner, associate drainage engineer, U. S. Department of Agriculture, on the development of irrigation on the eastern seaboard.

The drainage and land clearing groups held a joint session with H. B. Roe, associate professor of agricultural

engineering, University of Minnesota, presiding, assisted by L. F. Livingston, manager, agricultural extension section, E. I. du Pont de Nemours & Company. The papers on drainage included one by E. V. Willard, commissioner of drainage and waters, State of Minnesota, on the solution of an international drainage and flood control problem; one on the rehabilitation of drainage and levee districts by Clark E. Jacoby, president, Clark E. Jacoby Engineering Company; and one on the influence of drainage on forest growth by P. C. McGrew, assistant drainage engineer, U. S. Department of Agriculture.

On the subject of land clearing a paper prepared by A. T. Holman, agricultural extension engineer, North Carolina State College, on land clearing as a part in the development of the power and machinery program in the South was presented, also a paper on a land clearing investigational program in the State of Washington by L. J. Smith, professor of agricultural engineering, State College of Washington; a paper on teaching the use of explosives to college students by George Amundson, specialist in agricultural engineering, Michigan State College; and a report on the progress of land clearing work in Minnesota by M. J. Thompson, superintendent, Northeast Experiment Station, Duluth, Minn.

A short business session was held during the evening of the first day, at which the first order of business was the consideration of a proposed resolution for a research coordinator in land reclamation in the U.S.D.A. Division of Agricultural Engineering. Such a proposal had previously been considered by the executive committee of the Land Reclamation Division at a meeting which was held at Sioux City, Iowa, September 10. The proposal had been submitted to S. H. McCrory, chief of the U.S.D.A. Division of Agricultural Engineering, who outlined in a letter the arrangements that had been made and that would be made to coordinate research under the four main branches of land reclamation. In his letter Mr. McCrory explained that the coordination of research in irrigation, soil erosion control and land clearing was now well established and that the coming year a special coordinator would be provided for the drainage field. The Division voted to approve this plan for the coordination of research in land reclamation and expressed its appreciation of the arrangements made.

Considerable discussion was given to the place for the next mid-year meeting of the Division, and while no formal action was taken, it seemed to be the general concensus of those present that the next meeting should be held on the Pacific Coast. Considerable time was devoted at the business session to discussing revisions in the reclamation plank of the proposed platform of the Society. The revisions agreed upon were formally approved at the general session the following day.

Ivan D. Wood, chairman of the A. S. A. E. Land Reclamation Division, presided at the general sessions on December 31, and introduced, as the first speaker, W. G. Kaiser, president of the American Society of Agricultural Engineers, who delivered an address on the engineering factor in land reclamation. A paper prepared by E. R. Jones, professor of agricultural engineering, University of Wisconsin, on the subject of land reclamation for efficiency was the second number on the program. This was followed by an outstanding address on the subject, "Economic Justification for Reclamation Activities," by Dr. Elwood Mead, U. S. Commissioner of Reclamation.

The afternoon session was featured by a paper by J. C. Russel, professor of agronomy, University of Nebraska, on the use of supplemental water; a paper on the rehabilitation of irrigation districts by W. W. McLaughlin, associate chief, division of agricultural engineering, U. S. Department of Agriculture, and a paper by Roy N. Towl, president, Towl, Nelson & Schwartz, consulting engineers, on sedimentation factors in flood control, drainage and reclamation.

At the invitation of the Kansas City Engineers Club, those attending this meeting joined that body at its regular weekly luncheon on the first day of the meeting. Features of the luncheon were two excellent talks by Ivan D. Wood and Roy N. Towl.

Dr. Mead Presents Reclamation Considerations at Public Domain Commission Meeting

PRESIDENT HOOVER'S Commission on Conservation and Administration of the Public Domain assembled in Washington December 23. Twenty members and two ex-officio members (The Secretaries of the Interior and Agriculture) made up the commission. Dr. Elwood Mead (Hon. Mem. A.S.A.E.) commissioner of reclamation, U. S. Department of the Interior, is one of the members of the commission. At the meeting he presented a memorandum of considerations which should be incorporated in any report of the commission on a national reclamation policy.

The points of consideration suggested by Dr. Mead are briefly:

1. The respective spheres of federal and state authority over navigable and non-navigable streams
2. The influence of eeconomic changes during the past twenty-five years on state and federal reclamation policies
3. Has the federal reclamation policy been justified by its influence on national growth and prosperity and the opportunities for home-owning it has created
4. The nature of the demand for future reclamation development
5. The probable extent of reclamation by private enterprize in the future and what economic or other considerations will govern this activity
6. What should be included in a reclamation scheme to insure complete and successful development
7. Economic and financial problems of reclamation
8. Financing and construction of irrigation canals
9. The control and development of unimproved, privately-owned land
10. Cooperation of different agencies interested in the success of reclamation schemes
11. Disposal of public land at an appraised price
12. What principle should control the ownership of and revenue from power plants built as feature of reclamation projects
13. Coordination of all industries interested in reclamation.

Agricultural Engineers Speak at A.A.A.S. Meeting

AT THE annual meeting of the American Association for the Advancement of Science, held in Des Moines, Iowa, December 28 to 30, Henry Giese, senior agricultural engineer, U. S. Department of Agriculture, presented before Section M (engineering) a paper on "The Application of the Engineering Profession to the Farm Industry."

J. B. Davidson, head of the department of agricultural engineering at Iowa State College, addressed the same meeting on the subject of "Some Observations Concerning Industrial Development in the U.S.S.R."

The utilization of farm waste from the standpoint of chemical engineering was also considered. Dr. O. R. Sweeney, professor of chemical engineering at Iowa State College, talked on the subject.

American Engineering Council

SEVENTY-FIVE delegates representing the twenty-four member engineering societies were expected to attend the annual meeting of American Engineering Council held in Washington, January 9, 10 and 11. This general assembly, the legislative and policy-forming body of American Engineering Council, will be preceded by meetings of the executive committee and administrative board.

John F. Coleman, of the American Society of Civil Engineers, represented the American Engineering Council at the business conference held in Washington December 5 and 6 at the request of President Hoover.

Other December events reported by Council were a meeting to consider the matter of standard uniform registration laws for engineers and President Hoover's message to Congress, which contained many references to specific engineering projects. President Anson Marston of the American Society of Civil Engineers held the conference on registration laws following the passage at the annual meeting of the National Council of State Boards of Engineering Examiners of a resolution suggesting it. At this conference, held in New York on December 7, Major Gardner S. Williams represented American Engineering Council and stated that Council had taken no definite position on the subject of registration. He also called attention to a recent analysis made by Council, of registration laws of the various states, in which fifty-eight different items were analyzed and recorded about each of the twenty-seven state registration laws.

Engineering projects mentioned in President Hoover's message are waterways, flood control, public buildings, highways, airmail, commercial aviation, railways, merchant marine, electric power regulation, radio commission, Muscle Shoals, Boulder Dam, conservation and governmental reorganization. The President stated that construction is being withheld on the proposed floodway from the Arkansas River to the Gulf of Mexico via the Atchafalaya River until this proposal can be reviewed by engineers for any further recommendations. A conflict of opinion has arisen particularly on this portion of the Mississippi flood control program. Relative to highways he pointed out that road building must necessarily be a long continued program, but that the mileage of public roads, particularly in the agricultural districts, might be materially reduced by proper planning. As to federal aid in this matter, he said, "Federal aid in the construction of high systems in conjunction with the states has proved to be benefical and stimulating. We must ultimately give consideration to the increase of our contribution to these systems particularly with a view to stimulating the improvement of farm-to-market roads." His recommendations on Muscle Shoals were that the plants be dedicated to investigation and experimentation on a commercial scale in agricultural chemistry. Incidental to this recommendation he stated his policy on the matter of the government engaging in industry in the words "I do not favor the operation by the government of either power or manufacturing business, except as an unavoidable product or some other major public purpose."

On another subject of interest to the agricultural engineering profession, namely government reorganization, the President outlined the principles as follows, "It seems to me that the essential principles of reorganization are two in number. First, all administrative activities of the same major purpose should be placed in groups under single-headed responsibilitity; second, all executive and administrative functions should be separated from boards and commissions and placed under individual responsibility, while quasi-legislative and quasi-judicial and broadly advisory functions should be removed from individual authority and assigned to boards and commissions."

Abstracts of A.S.A.E. Meeting Papers Broadcast

RURAL electric papers presented at the Amherst meeting of the North Atlantic Section, A.S.A.E., and at the winter meeting of the Rural Electric Divison, are receiving an additional hearing through the courtesy of radio station WGY, Schenectady, New York.

This station is preparing and presenting short abstracts of these papers on its Thursday evening farm programs. They are presented as part of a series of talks on "Some Practical Solutions of Farm Electrification Problems." It is the aim of the broadcast to help the farmer-listeners to gain a general understanding and appreciation of rural electrification from all angles.

A.S.M.E. Announces Fiftieth Anniversary

THE fiftieth anniversary meeting of the American Society of Mechanical Engineers will be held in New York and Washington, D. C., April 5 to 9, 1930, according to announcement recently made by the Society.

A semi-annual meeting will be held later in the year at Detroit. June 9 to 12 is the time set for this meeting.

Personals of A.S.A.E. Members

E. E. Brackett, who has been acting chairman of the department of agricultural engineering, University of Nebraska, has recently been appointed to the chairmanship of the department succeeding O. W. Sjogren, who recently resigned to accept a permanent position with the Killefer Manufacturing Company.

Thomas D. Campbell, president, Campbell Farming Corporation, was recently chosen one of the representatives of the American Society of Mechanical Engineers on American Engineering Council, and more recently he has been elected a member of the Executive Committee of the latter organization.

A. H. Hoffman, research specialist in agricultural engineering, University of California, and **E. G. McKibben**, formerly assistant agricultural engineer, University of California, are joint authors of California Agricultural Experiment Station Bulletin No. 482, entitled "Substitutes for Wooden Breakpins." The bulletin presents practically the same material presented by the authors in a series of articles which ran in the May, June and July, 1928, issues of AGRICULTURAL ENGINEERING.

H. B. Josephson, research engineer, and **R. U. Blasingame**, head of the department of farm machinery at Pennsylvania State College, are joint authors of a "Progress Report on the Use of Small Electric Motors for (1) Cutting Ensilage, (2) Sawing Wood and (3) Grinding Feed," published by the Pennsylvania State College. It is based on the results of the Pennsylvania Rural Electric Project up to May, 1929.

Oscar W. Sjogren, who has been on leave of absence as chairman of the department of agricultural engineering of the University of Nebraska, has tendered his resignation to the University authorities and will continue with the Killifer Manufacturing Corp., Los Angeles, Calif., with whom he has been connected the past six months. He has recently been promoted to the position in that company of supervisor of research and development, his new duties being to collect data on the results of deep tillage with the company's machinery in various sections of this and other countries and to direct the development of improvements in the present line of equipment as well as of new machines.

E. J. Stirniman, associate professor of agricultural engineering, University of California, left in December for an extended trip to Russia, where he will assist the Russian government in engineering problems pertaining to farm machinery. He expects to spend two years in Russia.

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NOTHING ROLLS LIKE A BALL.

NEW DEPARTURE BALL BEARINGS

Necrology

Hiram Lew Wallace passed away Friday morning, December 6, due to complications which set in following an operation for appendicitis on December 4. He had had a severe attack of stomach trouble two weeks before and had been under his physician's care since that time. Mr. Wallace was born in Missouri in 1892; attended Oregon Agricultural College one semester, and received his bachelor's degree in agricultural engineering from Iowa State College in 1920. During the war he was gassed in the second battle of the Marne and after the armistice spent a winter with the army of occupation in Germany. Since 1925 he has become widely known among agricultural engineers and farm implement manufacturers through his work as engineer in charge of the Nebraska tractor tests. He has been affiliated with the A.S.A.E. since 1921.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Willard A. Banks, western advertising representative, The Farm Journal, 3233 Cortland Ave., Detroit, Mich.

Eugene R. Bowen, vice-president, Avery Power Machinery Co., Peoria, Ill.

Raymond A. Calvert, plant superintendent. The Frost & Wood Co., Ltd., Smiths Falls, Ont., Can.

Michael B. Fabrikant, professor and scientific investigator, Leningrad Polytechnical Institute, Leningrad, U.S.S.R.

Frederick E. Goetz, research assistant, Kansas State Agricultural College, Manhattan, Kans.

Masami Koga, professor, Kyoto Imperial University, Kyoto, Japan.

George M. Kriegbaum, chief engineer, International Harvester Co., Richmond Works, Richmond, Ind.

Howard Matson, extension architect, Kansas State Agricultural College, Manhattan, Kans.

Lyall H. Mitchell, experimental engineer, General Implement Co., Racine, Wis.

James W. Morse, plant engineer, John Bean Mfg. Co., Lansing, Mich.

Harry L. Pierson, Jr., president, Detroit Harvester Co., Detroit, Mich.

Harper Sibley, part owner and manager, Sibley Farms, Rochester, N. Y.

Howard W. Simpson, engineer, Ford Motor Co., Dearborn, Mich.

John R. Templin, consulting electrical engineer, Templin and Toogood, Consulting Engineers, Christchurch, New Zealand.

S. P. Vostroknutoff, professor of agricultural machinery, Agricultural High School, Kasan, U.S.S.R.

Transfer of Grade

Harold A. Arnold, instructor, University of Tennessee, Knoxville, Tenn. (Junior to Associate Member.)

O. K. Hedden, assistant agricultural engineer, U. S. Department of Agriculture. 615 Front St., Toledo, Ohio. (Junior to Associate Member.)

New A.S.A.E. Members

W. L. Adams, Jr., assistant to manager, Rockland Light & Power Co., Middletown, N. Y.

John A. Chater, chief engineer, Niagara Sprayer and Chemical Co., Inc., Middleport, N. Y.

Raymore D. MacDonald, agricultural machine designer, The Ann Arbor Machine Co., Shelbyville, Ill.

Ralph D. Mancinelli, assistant to chairman of standards committee, International Harvester Co., Chicago, Ill.

Sarkis M. Nahikian, sales manager, Blood-Brothers Machine Co., Allegan, Mich.

Transfer of Grade

Fred R. Jones, associate professor of agricultural engineering, A. & M. College of Texas, College Station, Tex. (Associate to Full Member.)

Clarence R. Zink, student trainee, Public Service Co. of Northern Illinois, Chicago, Ill. (Student to Junior Member.)

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available' section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Positions Open

CHIEF AGRICULTURAL OFFICER wanted to direct the work of a territorial agricultural department in India. Appointment is for a period of five years, with possibility of reappointment. Applicant should possess a master's degree in science or agriculture. Preference will be given to applicants who have had experience in large-scale agriculture and irrigation. The officer appointed will control and direct the research program and development work of the department in his territory. This will be mainly on irrigated land, much of which contains alkali. Appointee will be expected to take up his duties within three months. Candidates should submit applications before February 1, giving full information as to age, education, training and experience and giving references. PO-166.

DRAFTSMAN, who has had experience in laying out combines, threshers or similar heavy farm machinery, wanted b a well-known farm equipment manufacturer in the middle west. Position offers opportunity for advancement and will prove substantial and permanent to the right individual. PO-167.

Men Available

FARM MANAGER, with 15 years' experience in large-scale power farming and livestock operations, desires a position. Has had wide experience in development of both arid and irrigated lands with power machinery and equipment. Also some experience in land drainage. College degree and associate member of American Society of Agricultural Engineers. Salary and share in profits preferred. Would take some stock in a company organization. MA-167.

AGRICULTURAL ENGINEER, formerly director of experimental station and government agricultural and import expert of Kingdom of Yugoslavia, speaking all Slav languages fluently, wants position in agricultural college, commercial farm or dairy plant in research, experimental or extension work; would also like connection in a manufacturer's export department. Russian. Married. Age 31. Willing to go anywhere. MA-168.

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